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ECHINODERMATA FROM PEARL AND HERMES REEF

By
MAXIMILIAN HOLLY

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ECHINODERMATA FROM PEARL AND HERMES REEF

By

MAXIMILIAN HOLLY¹

CLASS HOLOTHURIOIDEA SIEBOLD, 1848

ORDER ACTINOPODA LUDWIG, 1891

FAMILY HOLOTHURIIDAE LUDWIG, 1894

SUBFAMILY HOLOTHURIINAE LUDWIG, 1894

Genus **HOLOTHURIA** Linné, 1758

Holothuria pardalis Selenka, 1867.

Five examples from Pearl and Hermes Reef, one from Waikiki, Hawaiian islands.

A common sea-cucumber widely dispersed throughout the Hawaiian Islands.
—C. H. E.²

ORDER PARACTINOPODA LUDWIG, 1891

FAMILY SYNAPTIDAE BURMEISTER, 1837

SUBFAMILY SYNAPTINAE OESTERGRÉN, 1898

Genus **OPHEODESOMA** Fisher, 1907

Opheodesoma spectabilis Fisher, 1907 (fig. 1).

Hawaiian islands, Pearl and Hermes Reef.

A new record for Pearl and Hermes Reef. The species has a wide distribution and is common in some of the larger bays of Oahu.—C. H. E.

CLASS ECHINOIDEA EHRENBERG, 1836

ORDER DIADEMATOIDA DUNCAN, 1889

SUBORDER AULODONTA JACKSON, 1912

FAMILY DIADEMATIDAE PETERS, 1853

¹ Dr. Maximilian Holly of Vienna presents the third paper of a series of publications resulting from investigations of Pacific faunas by Dr. Victor Pietschmann, Bishop Museum Fellow in Yale University, 1927-1928. The first paper is by Anton Böhm, "Distribution and variability of Ceratium in the northern and western Pacific": B. P. Bishop Mus. Bull. 87, 1931. The second paper is by Otto Schindler, "Sexually mature larval Hemiramphidae from the Hawaiian islands": B. P. Bishop Mus., Bull. 97, 1932. The manuscripts of the three papers were translated from the German by Margaret B. Edmondson.

² The initials C. H. E. refer to Dr. C. H. Edmondson, Zoologist at Bernice P. Bishop Museum, who made the notations.

Genus *DIADEMA* Gray, 1825*Diadema setosum* Leske, 1778.

Hawaiian islands, Pearl and Hermes Reef. A new record for the leeward Hawaiian islands.

The species has a wide range through the Indian and South Pacific oceans.
—C. H. E.

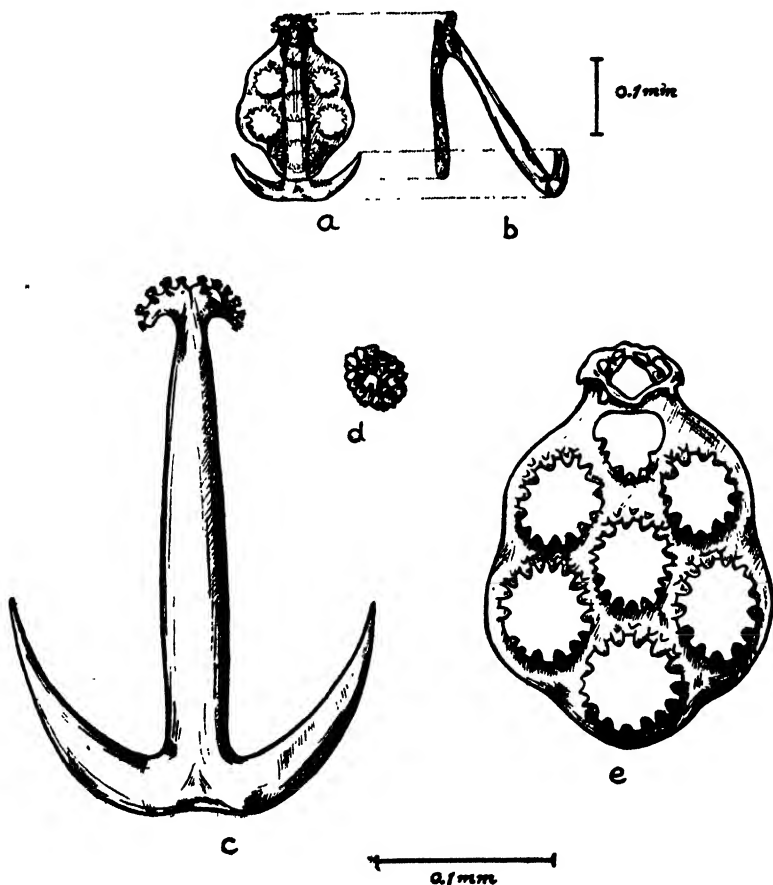


FIGURE 1.—*Opheodesoma spectabilis* Fisher, calcareous deposits: *a*, anchor in union with anchor plate, front view; *b*, side view; *c*, anchor; *d*, miliary granules; *e*, anchor plate.

SUBORDER CAMARODONTA JACKSON, 1912

FAMILY STRONGYLOCENTROTIDAE GREGORY, 1900

Genus **ECHINOSTREPHUS** A. Agassiz, 1863

Echinostrephus aciculatus A. Agassiz, 1863.

Hawaiian islands, Pearl and Hermes Reef.

Apparently a widely distributed species throughout the leeward Hawaiian islands and also known from Wake and Johnston islands. There are no records from the larger Hawaiian islands.—C. H. E.

FAMILY ECHINOMETRIDAE GRAY, 1855

Genus **ECHINOMETRA** Gray, 1825

Echinometra mathaei de Blainville, 1825.

One example from Kahuku, Oahu, Hawaiian islands; others from Pearl and Hermes Reef.

The most common sea urchin of the Hawaiian islands and widely distributed throughout the group.—C. H. E.

ORDER EXOCYCLOIDA JACKSON, 1912

SUBORDER CLYPEASTRINA GREGORY, 1900

FAMILY CLYPEASTRIDAE L. AGASSIZ, 1836

Genus **CLYPEASTER** Lamarck, 1801

Clypeaster lytopetalus A. Agassiz and Clark, 1907.

Hawaiian islands, Pearl and Hermes Reef.

A new record for Pearl and Hermes Reef. Previously recorded from near Laysan Island at depths ranging from 16 to 130 fathoms.—C. H. E.

SUBORDER ECHINONEINA HAWKINS, 1912

FAMILY ECHINONEIDAE WRIGHT, 1855

Genus **ECHINONEUS** Leske, 1778

Echinoneus cyclostomus Leske, 1778.

Hawaiian islands, Pearl and Hermes Reef.

A widely distributed species and apparently common throughout the leeward Hawaiian islands.—C. H. E.

SUBORDER SPATANGINA JACKSON, 1912

FAMILY SPATANGIDAE GRAY, 1825

Genus **BRISSUS** Leske, 1778

Brissus latecarinatus Leske, 1778.

Hawaiian islands, Pearl and Hermes Reef.

A common species distributed throughout the Hawaiian islands including the leeward islands as far as Kure Island.—C. H. E.

CLASS ASTERIOIDEA BRONN, 1860

ORDER PHANEROZONA SLADEN, 1889

SUBORDER VALVATA PERRIER, 1894

FAMILY OPHIDIASTERIDAE VERRILL, 1867

Genus **OPHIDIASTER** L. Agassiz, 1835

Ophidiaster squameus Fisher, 1906.

Hawaiian islands, Pearl and Hermes Reef.

A new record for Pearl and Hermes Reef. Previously recorded from Pailolo Channel between Maui and Molokai at depths from 130 to 151 fathoms, and near Kauai at depths from 18 to 41 fathoms.—C. H. E.

Genus **LINCKIA** Nardo, 1834

Linckia multifora (Lamarck, 1816).

Hawaiian islands, Pearl and Hermes Reef.

Apparently a new record for the leeward Hawaiian islands. The species seems to be common at Palmyra, Johnston, and Wake islands and is abundant on some of the reefs in Kaneohe Bay, Oahu. There is a specimen in Bernice P. Bishop Museum from off Fort Armstrong, Honolulu.—C. H. E.

ORDER SPINULOSA PERRIER, 1884

SUBORDER AVELATA VERRILL, 1914

FAMILY MITHRODIIIDAE PERRIER, 1894

Genus **MITHRODIA** Gray, 1840

Mithrodia fisheri, new species (fig. 2).

Mithrodia bradleyi Fisher, U. S. Fish Commission Bulletin for 1903, pt. 3, p. 1096, pl. 37, figs. 2, 3 (notes on peculiar specimen of *Mithrodia*).

One specimen is considered. $R=37$ mm. to 55 mm.; $r=11.5$ mm.; $R=3.21$ r to 4.78 r ; the width of arm at base measures 14 mm., which corresponds with that of its middle.

This interesting specimen corresponds in its characteristics quite closely with that form which Fisher describes as a "peculiar specimen" in the publication referred to above. The spiny covering of the actinal body side is only slightly less pronounced and I consider this form, supported by the present specimen, to be an undescribed species of the genus *Mithrodia*.

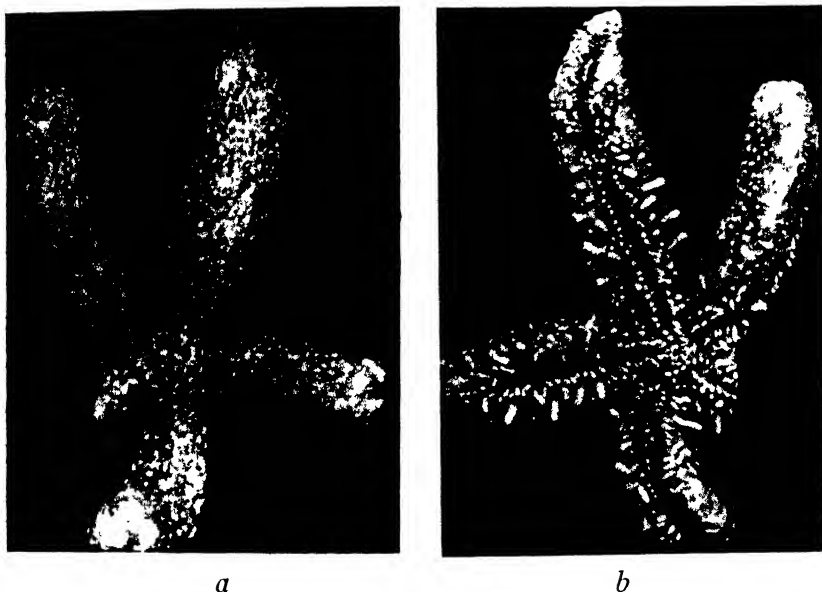


FIGURE 2.—*Mithrodia fisheri*, new species: *a*, view from above; *b*, view from below.

The individual arms are of unequal length since one has been broken off right at the base. This arm shows slight regeneration. There are five arms. They are roundish, somewhat dorso-ventrally compressed, therefore wider than high, at the base as wide or only slightly narrower than at the middle. The edge of the body disk between the arms is slightly rounded, more roundish than in *Mithrodia bradleyi* Verrill, but by no means so evenly indented as Fisher says of his specimen. The tough integument of the body and arms shows a somewhat thick network of costa under which lie the plates. The individual folds of this network, which hold the papulae, are covered by numerous very small, scattered granules. The ridge-like ribs are drawn out to short, knob-like elevations, which in their turn are decorated with sharp scale-like grains. These latter increase in size at the points of these elevations. The surface of the animal appears just as rough but not nearly so coarse as *M. bradleyi*. Stronger, longer spines are found but in smaller numbers and are set, as Fisher has said, only upon the actinal body side. They stand here

in two rows, as in *M. bradleyi*, but are much less strongly developed; however, in the specimen under consideration they are somewhat longer than Fisher describes them in his "peculiar specimen". This and the somewhat angularly marked body, or disk, edge between the arms are the only insignificant differences which my specimen shows from that which Fisher discussed. A lateral row of longer spines is wholly lacking. It may be worthy of mention also, that H. L. Clark in his work, "The Echinoderms of Peru," Bull. Harvard Mus. Comp. Zool., vol. 52, no. 17, 1910, p. 336, cites a *Mithrodia bradleyi* from "Arica, Peru" in which the size relation of R to r compares as 1 to 9. Such a size relation and somewhat below (8.5) Fisher also found in his Hawaiian specimens. From which it follows that the figure given in the Clark publication is quite clearly the typical form of the true *Mithrodia bradleyi* Verrill.

The madreporite is of usual medium size and lies halfway between disk edge and disk center.

The color of this specimen preserved in alcohol is yellowish white.

I name this new species in honor of Walter K. Fisher.

The specimen was taken in shoal water at Pearl and Hermes Reef. Fisher's specimens were dredged in the vicinity of Bird Island at depths ranging from 20 to 30 fathoms.—C. H. E.

CLASS OPHIUROIDEA NORMAN, 1865

ORDER OPHIURAE MÜLLER AND TROSCHEL, 1842

SUBORDER NECTOPHIURAE PERRIER, 1881

FAMILY OPHIOCOMIDAE LJUNGMANN, 1851

Genus OPHIOCOMA L. Agassiz, 1835

Ophiocoma pica Müller and Troschel, 1842.

Hawaiian islands, Pearl and Hermes Reef.

A common brittle-star widely dispersed throughout the Hawaiian islands.—C. H. E.

Ophiocoma brevipes Peters, 1851, variety **variegata** E. A. Smith, 1876.

Hawaiian islands, Pearl and Hermes Reef.

The most common brittle-star of the Hawaiian islands; distributed throughout the group.—C. H. E.

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THE LIZARDS OF THE MARQUESAS ISLANDS

By

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PUBLICATION 5

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THE LIZARDS OF THE MARQUESAS ISLANDS

By

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FIELD MUSEUM OF NATURAL HISTORY

and

WALTER L. NECKER

CHICAGO ACADEMY OF SCIENCES

The Pacific Entomological Survey, conducted by E. P. Mumford and A. M. Adamson, under the auspices of Bernice P. Bishop Museum, began its work in the South Pacific in 1928, concentrating chiefly on the Marquesan archipelago. In the course of the Crane Pacific Expedition of Field Museum of Natural History the senior author met Mr. Mumford and Mr. Adamson at Atuona, their headquarters in the Marquesas. In conversation with them, the opportunity for study offered by the lizard fauna was a topic of mutual interest; and the suggestion was made by the senior author that if sufficient series of specimens of each of the species from the individual islands were available for statistical examination, some clue to the beginnings of species formation by isolation might be detected. The numbers of specimens required for such a study would be large, and it would be necessary to have them especially prepared for rapid examination. Such a collection was felt to be beyond the scope of the Pacific Entomological Survey. In the course of their work, however, Mr. Mumford and Mr. Adamson and others at their direction collected 223 specimens of lizards. These were forwarded to Field Museum for identification and study. The following list records this material with its distribution. The highlight of the collection lies in its record of the presence in the Marquesas of the gecko *Hemiphyllodactylus leucostictus*, hitherto known only from Hawaii. The writers are indebted to E. H. Bryan, Jr., Curator of Collections, Bernice P. Bishop Museum, for the opportunity to examine this material, and to Mr. Mumford and Mr. Adamson for their interest in collecting it.

The senior author¹ has recorded his impressions of the distributional significance of the Polynesian lizards, six species of which range from island to island throughout the Pacific. The species of *Hemiphyllodactylus* in the Hawaiian islands apparently afforded a reptilian element of faunal distinctness to that most remote of oceanic island groups; but with the present records of this species from the Marquesas, the uniformity of the lizard fauna of the Pacific islands is more emphasized than ever.

The collection at hand includes two species of geckos and one of skinks from Tahiti; these are *Gehyra oceanica* from Tuaru Valley, September 6, 1928, a *Lepidodactylus lugubris* from Fautaua Valley, September 13, 1928, and a second specimen of the same species from Paea, August 29, 1928, and one *Lciolopisma noctua* from Tuaru Valley, September 6, 1928, all collected by A. M. Adamson. These species have previously been recorded from Tahiti.

The remainder of the collection comes from the Marquesas, with nine islands represented. With the exception of the few specimens recorded from Nukuhiva and Hivaoa by the senior author,² actual records of the species of lizards in this archipelago appear to be wanting. The present list accordingly fills a conspicuous gap in our knowledge of the Polynesian lizard fauna.

To increase the usefulness of the present paper to visitors to the South Sea islands who may interest themselves in the lizards, we have included a key to the species as an aid to their identification, inserting figures to illustrate the technical characters employed. These illustrations, with the exception of figures 1a, 3c, and 4c, are from Stejneger's report³ on the Hawaiian lizards.

¹ Schmidt, K. P., Essay on zoögeography of the Pacific islands: appendix in Shurcliff, S. N., *Jungle Islands*, pp. 275-292, 1930.

² Schmidt, K. P., A list of the lizards collected by R. H. Beck in the southern Pacific, November, 1920, to May, 1921: *Copeia*, pp. 90-92, 1921. Second report on lizards secured by the Whitney South Seas Expedition: *Copeia*, pp. 23-24, 1922.

³ Stejneger, Leonhard, The land reptiles of the Hawaiian islands: U. S. Nat. Mus., Proc., vol. 21, pp. 783-813, 1899.

KEY TO THE SPECIES

- a. No large symmetrical shields on top of head; body covered with small granules or minute scales; digits dilated; pupil vertical.....GEKKONIDAE

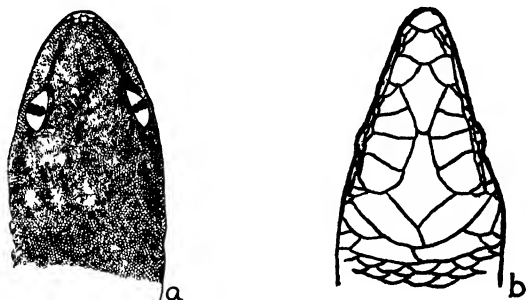


FIGURE 1. Top of head: *a*, gecko (*Gehyra*) showing granular scales; *b*, skink (*Emoia*), showing large symmetrical shields.

- b. Compressed distal phalanx of digits adhering to the dilated portion and extending somewhat beyond it, but not rising angularly from within the edge; chin shields not differentiated..... ***Lepidodactylus lugubris***



FIGURE 2. Side view of digit: *a*, *Lepidodactylus*; *b*, *Hemidactylus*.

- bb. Compressed distal phalanx of digits free, rising angularly from within the edge of the dilated portion.

- c. Inner digits with distal phalanx compressed and clawed.....
..... ***Hemidactylus garnotii***

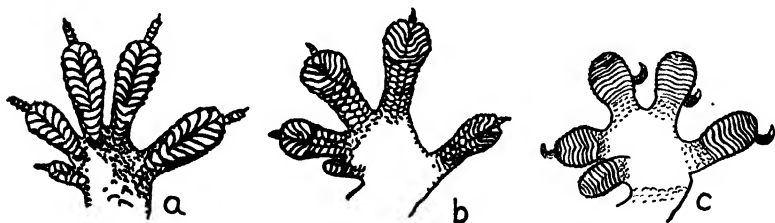


FIGURE 3. Underside of foot: *a*, *Hemidactylus garnotii*, showing lamellae in two series; *b*, *Hemiphyllodactylus leucostictus*; *c*, *Gehyra oceanica*, showing single lamellae.

- cc. Inner digits without a distal compressed phalanx.
 d. Chin-shields large; a series of transverse plates under tail.
 e. Subdigital lamellae in two series..... **Peropus mutilatus**
 ee. Subdigital lamellae single..... **Gehyra oceanica**
 dd. Chin-shields not differentiated; no transverse plates under tail.....
 **Hemiphyllodactylus leucostictus**

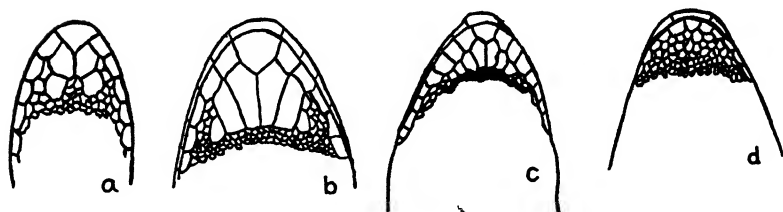


FIGURE 4. Chin-shields: a, *Hemidactylus garnotii*; b, *Peropus mutilatus*; c, *Gehyra oceanica*; d, *Lepidodactylus lugubris*. Showing variously enlarged plates.

- aa. Top of head with large symmetrical shields; body scales large, cycloid; digits not dilated; pupil round..... **SCINCIDAE**
 b. Eyelids well developed, movable.
 c. Nostril pierced in the nasal; no supranasal; frontoparietals and interparietals distinct; two or three pairs of nuchals... **Leiopisma noctua**

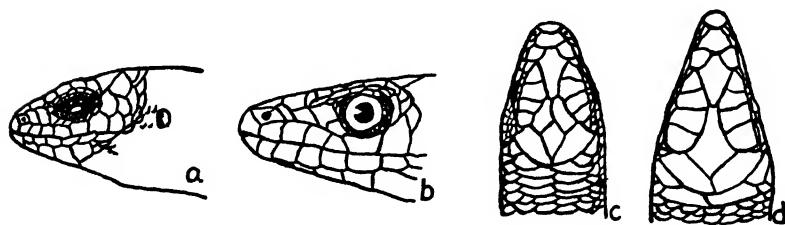


FIGURE 5. Head: side view, a, *Leiopisma noctua*, showing lower eyelid with transparent disk; b, *Ablepharus boutonii poecilopleurus*, showing eyelid indistinguishable; top, c, *Leiopisma noctua*; d, *Emoia cyanura*.

- cc. Nostril pierced between three small shields, a nasal, a postnasal, and a supranasal; frontoparietal and interparietal fused into a single large shield; a pair of nuchals..... **Emoia cyanura**
 bb. Eyelids indistinguishable, not movable.....
 **Ablepharus boutonii poecilopleurus**

GEKKONIDAE

Lepidodactylus lugubris (Duméril and Bibron). Mourning Gecko
Platyedactylus lugubris Duméril and Bibron, *Erpét. Gén.*, vol. 3,
p. 304, 1836.

Lepidodactylus lugubris Fitzinger, *Syst. Rept.*, p. 98, 1843.

This common species is represented by 33 specimens from seven islands. It may usually be distinguished at a glance from the other Polynesian geckos by its pale coloration with black spots or markings.

Mohotani: altitude 700 feet, 1 specimen, February 2, 1931, LeBronnec and H. Tauraa.

Tahuata: Vaitahu, 7 specimens, May 31, 1930, LeBronnec and H. Tauraa.

Fatuhiva: Omoa [Oomoa] Valley, 1 specimen, September, 1930; Omoa [Oomoa] Valley, altitude 150 feet, 4 specimens, September, 1930, LeBronnec.

Uapou: Hakahetau Valley, sea level, 8 specimens, December 4, 1931, LeBronnec.

Eiao: altitude 1,600 feet, 3 specimens, April 23, 1931, LeBronnec and H. Tauraa. Middle of island, altitude 1,400 feet, 1 specimen, October 20, 1929; uplands, northeast, altitude 1,850 feet, 1 specimen, September 29, 1929; altitude 1,600 feet, 3 specimens, September 29, 1929, A. M. Adamson. Altitude 1,600 feet, 1 specimen, April 30, 1931, LeBronnec and H. Tauraa.

Hivaoa: Atuona, 1 specimen, February 16, 1928, Mumford and Adamson.

Uahuka: Teavamataiki, altitude 750 feet, 3 specimens, March 19, 1931, LeBronnec and H. Tauraa.

Hemidactylus garnotii Duméril and Bibron. Fox Gecko

Hemidactylus garnotii Duméril and Bibron, *Erpét. Gén.*, vol. 3,
p. 368, 1836.

This species is represented by six specimens from four islands. The development of calcareous deposits in the post-auricular region is noteworthy in the larger specimens. *H. garnotii* is distinguished most easily by its longer head and distinctive chin-shields.

Mohotani: altitude 350 feet, 1 specimen, February 4, 1931, LeBronnec and H. Tauraa.

Uapou: Hakahetau Valley, sea level, 3 specimens, December 4, 1931, LeBronnec.

Eiao: altitude 1,600 feet, 1 specimen, April 30, 1931, LeBronnec and H. Tauraa.

Hivaoa: Tepehi, altitude 1,500 feet, 1 specimen, June 1, 1929, Mumford and Adamson.

Peropus mutilatus (Wiegmann).

Stump-toed Gecko

Hemidactylus mutilatus Wiegmann, Herpet. Mex., vol. 1, p. 54, 1834.

Peropus mutilatus Stejneger, U. S. Nat. Mus., Proc., vol. 21, p. 796, 1899.

Seventeen specimens from six islands. The combination of elongate chin-shields with divided lamellae on the subdigital expansions suffices to distinguish this species.

Mohotani: altitude 350 feet, 2 specimens, February 4, 1931; altitude 700 feet, 2 specimens, February 2, 1931; LeBronnec and H. Tauraa.

Tahuata: Vaitahu Valley, 1 specimen, November 15, 1929, Victor Doom.

Fatuhiva: Omoa [Oomoa] Valley, altitude 150 feet, 6 specimens, September, 1930, LeBronnec.

Uapou: Hakahetau Valley, sea level, 3 specimens, December 4, 1931, LeBronnec.

Hatutu [Hatutaa]: altitude 1,080 feet, near middle, 1 specimen, September 3, 1929, A. M. Adamson. Altitude 1,000 feet, 1 specimen, April 28, 1931, LeBronnec and H. Tauraa.

Fatuuku: altitude 990 feet, 1 specimen, September 13, 1931, H. Tauraa.

Gehyra oceanica (Lesson).

Polynesian Gecko

Gecko oceanicus Lesson, Zool. Voy. Coquille, vol. 2, pt. 1, p. 48, pl. 3, fig. 4, 1830.

Gehyra oceanica Gray, Zool. Misc., p. 58, 1842.

Forty specimens from six islands. Seven eggs of this species were collected at Omoa [Oomoa] Valley, Fatuhiva Island, by LeBronnec, on September 16, 1930. These vary in length from 13.2 mm. to 14.3 mm. and in shorter diameter from 12.0 mm. to 12.6 mm. They are laid separately, like those of *Gehyra vorax*, not in pairs as in *Lepidodactylus lugubris*. *Gehyra oceanica* is the largest lizard

of the Marquesas. The broad expansion of its toes, with curved undivided lamellae on the under side, are characteristic.

Mohotani: altitude 700 feet, 1 specimen, February 2, 1931, LeBronnec and H. Tauraa.

Tahuata: Vaitahu, 10 specimens, May 31, 1931, LeBronnec and H. Tauraa.

Fatuhiva: Omoa [Oomoa] Valley, altitude 350 feet, 1 specimen, September 16, 1930; altitude 150 feet, 5 specimens, September, 1930, LeBronnec.

Uapou: Hakahetau Valley, sea level, 20 specimens, December 4, 1931, LeBronnec.

Eiao: altitude 1,600 feet, 2 specimens, April 30, 1931, LeBronnec and H. Tauraa.

Hivaoa: Atuona, 1 specimen, February 15, 1929, Mumford and Adamson.

Hemiphyllodactylus leucostictus Stejneger. Stejneger's Gecko

Hemiphyllodactylus leucostictus Stejneger, U. S. Nat. Mus., Proc., vol. 21, p. 800, fig. 7-9, 1899.

Three specimens from three islands form the first record of this species outside the Hawaiian archipelago. These agree in detail with both generic and specific diagnosis given by Stejneger for Hawaiian specimens. The agreement in such details of coloration as the five white spots on the bases of the digits and the transverse white mark at the base of the tail convinces us that the Marquesan specimens should unquestionably be referred to the Hawaiian species. Two of the Marquesan specimens lack the median brown marbling of the underside of the tail mentioned by Stejneger, but this is indicated in the third specimen. The coloration of the adult *H. leucostictus* corresponds closely with that of juvenile *Gehyra oceanica*.

The occurrence of this species in the Marquesas suggests that it should be looked for in Tahiti and other Polynesian Islands. It may most readily be distinguished by the absence of chin-shields, brown color with white spots, and the shortness of the expanded portion of the fingers and toes.

Without East Indian material for comparison we are not ready to accept the reference of this species to the synonymy of *Hemiphyllodactylus typus* (Bleeker) as has been suggested by Brongersma.⁴

⁴Brongersma, L. D., Reptilia: Res. Sci. Voy. Indes Orientales Neerlandaises, vol. 5, fasc. 2, pp. 1-39, 1 map, pls. 1-4, 1931.

Mohotani: altitude 700 feet, 1 specimen, February 2, 1931, LeBronnec and H. Tauraa.

Eiao: altitude 1,600 feet, 1 specimen, April 23, 1931, LeBronnec and H. Tauraa.

Hivaoa: Kopaafaa, altitude 2,800 feet, 1 specimen, August 3, 1929, Mumford and Adamson.

SCINCIDAE

Leiolopisma noctua (Lesson).

Moth Skink

Scincus noctua Lesson, Zool. Voy. *Coquille*, vol. 2, pt. 1, p. 48. pl. 3, fig. 4, 1830.

Leiolopisma noctua Stejneger, U. S. Nat. Mus., Proc., vol. 21, p. 805, 1899.

This species is represented by no less than 87 specimens from seven islands. The usual recognition character for this species is a median light line on the back which stops on the occiput with a distinct expansion into a spot. The edges of the line are diffused, never sharp as in *Emoia*. Rare specimens may have the dorsal line and spot obscure.

Mohotani: 2 specimens, February, 1931; altitude 700 feet, 17 specimens, February 2, 1931; altitude 325 feet, above Anaoa, 2 specimens, August 13, 1929; altitude 700 feet, coconut plantation, 1 specimen, January 31, 1931, LeBronnec and H. Tauraa.

Taahuata: Vaitahu, 22 specimens, May 31, 1930, LeBronnec and H. Tauraa.

Fatuhiva: Omoa [Oomoa] Valley, 24 specimens, September, 1930, LeBronnec.

Uapou: Hakahetau Valley, sea level, 8 specimens, December 4, 1931; Koputukea, altitude 1,150 feet, 1 specimen, November 16, 1931, LeBronnec.

Hivaoa: Atuona, 1 specimen, February 16, 1928, Mumford and Adamson.

Fatuuku: altitude 990 feet, 4 specimens, September 19, 1930. H. Tauraa.

Eiao: altitude 1,600 feet, middle of island, 1 specimen, September 28, 1929, A. M. Adamson.

Emoia cyanura (Lesson).

Azure-tailed Skink

Scincus cyanurus Lesson, Zool. Voy. *Coquille*, vol. 2, pt. 49, pl. 4, fig. 2, 1830.*Emoia cyanura* Stejneger, U. S. Nat. Mus., Proc., vol. 21, p. 807, 1899.

Twenty-three specimens from four islands. This species is immediately distinguishable from the other skinks by the sharply defined, light mid-dorsal line which extends to the tip of the snout, and the bright blue tail. Six specimens have the mid-dorsal line to a varying extent confined to a single mid-dorsal row of scales; this variation, however, appears to be erratic, for it is represented in the series from each island.

Mohotani: 2 specimens, February 1, 1931; 1 specimen, February 2, 1931; altitude 1,700 feet, 1 specimen, February 1, 1931, LeBronnec and H. Tauraa.

Tahuata: Vaitahu, 4 specimens, May 30, 1930; 2 specimens, May 31, 1930, LeBronnec and H. Tauraa.

Fatuhiva: Omoa [Oomoa] Valley, 8 specimens, September, 1930, LeBronnec.

Uapou: Hakahetau Valley, sea level, 5 specimens, December 4, 1931, LeBronnec.

Ablepharus boutonii poecilopleurus (Wiegmann). Snake-eyed Skink*Ablepharus poecilopleurus* Wiegmann, Nova Acta Acad. Ceas.

Leop.-Carol., vol. 17, pt. 1, p. 202, pl. 18, figs. 1-1a, 1835.

Ablepharus boutonii poecilopleurus Boulenger, Cat. Liz. Brit. Mus., vol. 3, p. 347, 1887.

Two specimens from Hatutu [Hatutaa] are the only ones secured by the Pacific Entomological Survey. These agree excellently with the recent diagnosis of this form by Mertens,⁵ and we have followed his nomenclature. Specimens from the Fiji Islands are distinguished as *A. b. eximius* by Mertens, and the validity of this form is supported by the characters of Field Museum specimens from Fiji.

The snake-eyed skink is at once distinguished by the apparent absence of eyelids and the lack of a mid-dorsal light line.

⁵ Mertens, Robert, *Ablepharus boutonii* (Desjardin) und seine geographische Variation: Zool. Jahrb., Syst. Abt., vol. 61, pp. 63-210, 6 figs., 3 pls., 1931.

CYPRAEACEA FROM HAWAII

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INTRODUCTION

In 1928 Dr. Victor Pietschmann, Ichthyologist of the Museum of Vienna, Austria, collected some marine Mollusca on the beaches of Pearl and Hermes Reef, Laysan Island, and French Frigates Shoal, Hawaii. The Cypraeacea (including the families Eratoidae, Cypraeidae, and Amphiperatidae) have been referred to the writer by Dr. W. Adensamer, Curator of Mollusca, Museum of Vienna.

The collection contains 594 specimens belonging to 19 species. Most of them are well-known shells found on other Hawaiian islands. Nevertheless the collection is interesting, as it proves that some Hawaiian species range as far north as Pearl and Hermes Reef, latitude 28 degrees. Also, the rather large number of individuals of many species makes possible the investigation of local variability by the methods of statistics.¹

Distribution of species of Cypraeacea previously credited to the Hawaiian islands, especially to Oahu, Kauai, Hawaii, and Maui, and those found by Dr. Pietschmann in the leeward islands, is shown in Table 1. Fifty-four species have been credited to the Hawaiian islands, but of these, 11 species must be rejected and 15 need further confirmation. Of the 28 species that have undoubtedly been found on the shores of the larger islands, 19 were collected at French Frigates Shoal, Laysan Island, and Pearl and Hermes Reef. Nine of these 28—or 43—Hawaiian species are confined to the Hawaiian islands, though allied species occur in other parts of the Pacific (*Pustularia tessellata* is the only species without close relations to other living Cypraeacea). Four—or 6—species also occur in other islands of Polynesia, 7 species range to eastern Asia or Australia, and 8—or 21—species are distributed as far as the Indian Ocean.

¹ Schilder and Schilder, Eine Ausbeute von Cypraeacea aus Port Alfred: Ann. Nat. Mus., Wien, vol. 43, p. 229, 1929. Variationsstatistische Studien an *Monetaria annulus*: Mitt. Zool. Mus. Berlin, vol. 16, p. 543, 1930.

* This is the fourth in a series of publications resulting from investigations of Pacific faunas by Dr. Victor Pietschmann, Bishop Museum Fellow in Yale University, 1927-1928. The first paper is by Anton Böhm, "Distribution and variability of Ceratium in the northern and western Pacific": B. P. Bishop Mus., Bull. 87, 1931. The second paper is by Otto Schindler, "Sexually mature larval Hemiramphidae from the Hawaiian islands": B. P. Bishop Mus., Bull. 97, 1932. The third paper is by Maximilian Holly, "Echinodermata from Pearl and Hermes Reef": B. P. Bishop Mus., Occ. Papers, vol. 10, no. 1, 1932.

All species found by Dr. Pietschmann in the leeward Hawaiian islands have also been observed in the eastern islands before, but his collection includes one species (*Mauritia scurra*) which was unknown to Garrett, and two species (*Lyncina arenosa*, *Talostolida rashleighana*) unknown to both Garrett and Baldwin. Dr. Pietschmann did not collect *Mauritia mauritiana*, *Staphylaea polita*, and *Cribraria gaskoini*, which are rather common on the larger eastern islands, so one would suggest that these do not range to the western islands.

In descriptions and collection records of species the following abbreviations have been used:

FF = French Frigates Shoal, March 4-5, 1928.

FK = French Frigates Shoal, King Island, March 5, 1928.

LA = Laysan Island, March 1, 1928.

PH = Pearl and Hermes Reef, without precise indication of island or date.

PE = Pearl and Hermes Reef, Southeast Island.

PG = Pearl and Hermes Reef, Grass Island.

PS = Pearl and Hermes Reef, Sand Island, February 18, 1928.

Ma = maximum length of shell.

Mi = minimum length of shell.

X = number of specimens (4X = four specimens).

L = length of shell in mm.

BL = relative breadth ($100 \times \text{breadth} : \text{length}$).

HL = relative height ($100 \times \text{height} : \text{length}$).

LT = number of labial teeth from anterior extremity of outer lip to interior of posterior outlet.

CT = number of columellar teeth, excluding anterior terminal ridge (generally widely separated from the following teeth) and slight crenulations on left border of posterior outlet.

IR = intercalate ribs on the inner lip of *Nuclearia*.

MR = marginal ribs, number of ribs crossing periphery of shell.

DR = dorsal ribs, number of ribs starting from dorsal sulcus or median line in both directions (the dorsum therefore is crossed by one-half the number of dorsal ribs), the rather longitudinal ribs on both extremities excluded.

Dimensions, proportions, and number of teeth of the shell have been expressed by a formula, as, $22(66/52)20:17$, which expresses: L, 22; BL, 66; HL, 52; LT, 20; CT, 17. In Triviinae there are two accessory figures, and the formula runs as follows, $5.1(80/71)16:12/46:18$, which expresses: L, 5.1; BL, 80; HL, 71; LT, 16; CT, 12; MR, 46; DR, 18 (the dorsum is crossed by $18:2$, or 9, ribs).

In the text tables given with discussions of species to show the differences between populations from different islands and regions, the second figure of each character (L, BL, HL, LT, CT, MR, DR) indicates the mean, whereas the first and third figure indicate the limits of 50 per cent of the specimens investigated which approach

the mean.² The absolute extremes observed have been indicated only with regard to the length of the shell with respect to maximum and minimum length.

NOTES TO TABLE 1

1. Abbreviations used in the table are:

H = confined to Hawaii.

P = found in Hawaii and in small islands of Micronesia and eastern Polynesia, but not as far west as Fiji and New Caledonia.

S = widely distributed in the South Pacific east of Malacca.

I = living in the Indian Ocean and Pacific Ocean.

GR = credited to Hawaii by Gray (Ann. Mag. Nat. Hist., ser. 3, vol. 2, p. 49, 1858).

MA = credited to Hawaii by Martens and Langkavel (Südsee-Conchylien: Donum Bismarckianum, p. 65, Berlin, 1871).

GA = credited to Hawaii by Garrett (Jour. Conch., vol. 2, p. 105, 1879).

BA = credited to Hawaii by Baldwin (Nautilus, vol. 11, p. 123, 1898). Species not personally known to Baldwin are marked "o" instead of "X".

HI = credited to Hawaii by Hidalgo (Mem. Ac. Cienc. Madrid, vol. 25, p. 182, 1906—includes review of all localities given by previous writers).

M = Hawaiian specimens preserved in museums and private collections examined by the writer.

F = number of specimens collected at French Frigates Shoal.

L = number of specimens collected at Laysan Island.

P = number of specimens collected at Pearl and Hermes Reef.

2. Pease's description of 1860 (*Erato sandwicensis*) is antedated by that of Sowerby (Thes. Conch., vol. 3, 1859).

3. Schilder (Zoolog. Anz., vol. 96, p. 71, 1931).

4. *Trivia globosa* Sowerby and *T. sphaerula* Mighels.

5. *Trivia sphaerula* Mighels.

6. *Cypraea (Trivia) insecta* Mighels.

7. Shaw (Malac. Soc. London, Proc., vol. 8, p. 310, 1909).

8. *Cypraea (Trivia) oryza* Lamarck.

9. *Cypraea (Trivia) grando* Gaskoin.

10. Mus. Vienna: 6.9 (66/—) 31 :26/— :27, rostrate, dorsal sulcus shallow, sometimes crossed by the ribs (collected by Pease).

11. *Cypraea termeza* Duclos.

12. Schilder (Zoolog. Anz., vol. 100, p. 165, 1932).

13. *Cypraea reticulata* Martyn.

14. The question mark (?) indicates species the occurrence of which needs confirmation. Species that should be excluded from the Hawaiian fauna are named, but not numerated.

15. Schilder (Malac. Soc. London, Proc., vol. 19, p. 50, 1930).

16. *Cypraea intermedia* Gray.

17. *Cypraea gillei* Jousseaume.

18. Writer's collection: 33 (70/50) 23:17, said to come from Hawaii, but collector unknown.

19. Young or oblong specimens of *Mauritia maculifera* may have been mistaken for *M. arabica*.

² "Halftespielraum." See Johannsen: Elem. exakt. Erblichkeitslehre, 3d ed., p. 22, 1926.

Table 1. Hawaiian Cypraea (1)

(Numbers in parentheses refer to notes, page 5.)

Name of Species	Distribution	GR	MA	GA	BA	HI	M	F	L	P
1. <i>Erato sandwicensis</i> Sowerby (2)	H		X	X (4)	0(5)	X	X	4		
2. <i>Cleopatra pilula</i> Kinner (3)	S		X (6)	X (6)	X (6)	X (6)	X	115		49
3. <i>Trivirostra hordacea</i> Kinner	S		X (8)	X (8)	0(8), X (9)	X (8,9)	X (10)	18		
4. <i>Trivirostra edgari</i> Shaw (7)	I						X	24		5
5. <i>Trivirostra pelliculata</i> Gaskoin	I						X	15		11
6. <i>Trivirostra exigua</i> Gray	I		X (11)	X	0	X	X			
7. <i>Mauritia mauritiana</i> Linnaeus	P		X (13)	X (13)	X (13)	X (13)	X	9		
8. <i>Mauritia maculifera</i> Schilder (12)	P		X (13)	X (16)	X (16)	X (17)	X (18)			
9. ? (14) <i>Mauritia depressa</i> Gray (15)	P									
10. ? (19) <i>Mauritia arabica</i> Linnaeus	I									
11. ? <i>Mauritia scurra</i> Gmelin	S									
12. ? <i>Palpurina argus</i> Linnaeus	I									
13. ? <i>Palpurina lineata</i> Linnaeus	I			X	X	X	X			
14. ? (19-a) <i>Cypraea tigris</i> Linnaeus	I			X	X	X	X			
15. ? <i>Lyncina lynx</i> Linnaeus	I			X	X	X	X			
16. ? <i>Lyncina ventriculus</i> Lamarck	I			X	X	X	X			
17. ? <i>Lyncina vitellus</i> Linnaeus	I			X	X	X	X			
18. <i>Lyncina carnea</i> Linnaeus	I			X	X	X	X			
19. <i>Lyncina arenosa</i> Gray	P			X	X	X	X			
20. <i>Lyncina sulcidentata</i> Gray	H	X		X	X	X (21)	X	1		
21. <i>Basilitrona isabella</i> Linnaeus	I	X		X	X	X	X	1	23	36
22. ? <i>Monetaria annulus</i> Linnaeus	I	X		X	X	X	X	1	3	71
23. ? <i>Monetaria moneta</i> Linnaeus	I			X	X	X	X			
24. ? <i>Pustularia tessellata</i> Sowerby	H			X	X	X	X			
24. (23) <i>Pustularia globulus</i> Linnaeus	I			X	0	X	X			
25. ? <i>Pustularia cicercula</i> Linnaeus	I			X	X	X	X			
26. ? <i>Ipsa childreni</i> Gray	I			X	X	X	X			
27. <i>Ravitriona caputangui</i> Philippi	S			X (24)	X (25)	X (26)	X	7	2	1
28. <i>Erosaria helvola hawaiiensis</i> Melvill	H	X (27)		X (27)	X (27)	X (28)	X	1	1	59
29. <i>Erosaria poraria</i> Linnaeus	I			X	X	X	X			
30. ? <i>Erosaria erosa</i> Linnaeus	I			X	X	X	X			
31. <i>Staphylaea semipilosa</i> Roberts	S	X (30)	X (31)	X (32)	0(30)	X (33)	X (29)		1	59
32. <i>Staphylaea solida</i> Roberts	H			X	X	X	X (34)			
33. ? <i>Staphylaea solida</i> Roberts	I	X (35)		X	X	X	X			
34. ? <i>Staphylaea interstincta</i> Wood	I			X (36)	0(36)	X (36)	X (37)			
35. <i>Staphylaea staphylaea</i> Linnaeus	I			X (38)	0	X	X			
(39) <i>Nuclearia nucleus</i> Linnaeus	I			X	X	X	X			
35. <i>Nuclearia honolulensis</i> Melvill (40)	H	X (41)	X (41)	X (41)	X (41)	X (41)	X			7
36. ? <i>Erronea erronea</i> Linnaeus	I			X	X	X	X			
<i>Erronea caurica</i> Linnaeus	I	X (42)				X	X			
<i>Erronea chinensis</i> Gmelin	I	X (42)				X	X			
<i>Blasicrura stollia</i> Linnaeus	I					X	X			
<i>Blasicrura erythraeensis</i> Sowerby	I					X	X			
37. <i>Palaeostoma teres</i> Gmelin	I					X	X			
38. <i>Talpa</i> (43) <i>talpa</i> Melvill	I					X	X			
39. <i>Palmadusta waikikiensis</i> new species (44)	H			X (46)	X (46)	X (46)	X (43)	1		1
40. <i>Palmadusta unifasciata</i> Mighels (47)	S	X (45)		X	0, X (48)	X (48)	X (44)			6
<i>Palmadusta artuffeli</i> Jousseaume	I					X	X			
<i>Cribraria caoutropia</i> Duclos	H					X	X			
<i>Cribraria gaskoini</i> Reeve	I	X	X (50)			X	X			
<i>Cribraria facheri</i> Vaysièrè	P					X	X			
42. <i>Pediculariella pacifica</i> Pease (52)	S					X	X			
43. <i>Procalpurnus semistriatus</i> Pease	S					X	X			

19-a. C. M. Cooke told me that there is no authentic specimen of *Cypraea tigris* from Hawaii (see Schilder, Zoolog. Anz., vol. 100, p. 165, 1932).

20. One shell in Dautzenberg collection, Paris; 69 (63/54).

21. "Sandwich (Upolu)" is evidently a slip.

22. Rochebrune's specimens of *Monetaria annulus* and *M. moneta icterina* Lamarck, said to come from Hawaii (see Schilder: Malac. Soc. London, Proc., vol. 19, p. 55, 1930), do not prove the occurrence of these species in the islands. *M. moneta* has been used for adornment by the natives of Hawaii (see Finsch: Südseearbeiten, p. 112, 1914), but that fact does not prove anything.

23. The Hawaiian specimens probably belong to *Pustularia cicercula*.

24. The occurrence of the typical *Ravitriona caputserpentis* Linnaeus has been rejected by Garrett.

25. *Cypraea caputanguis* Philippi and *C. caputserpentis* Linnaeus.

26. *Cypraea caputserpentis* Linnaeus.

27. *Cypraea helvola* Linnaeus.

28. *Cypraea helvola* Linnaeus and *C. citrina* Gray; young specimens of *C. helvola* have often been mistaken for *C. citrina*, which is confined to the southwestern Indian Ocean.

29. A necklace composed of some *Erosaria eburnea*, used by the natives of Hawaii and now preserved in the British Museum (Natural History), Department of Ethnology, does not prove the occurrence of this species on the islands.

30. The second variety of *Cypraea staphylaea*, well described by Gray.

31. The young shells have been incorrectly separated from *Staphylaea semiplota* as *C. spadix* Mighels.

32. *Cypraea spadix* Mighels.

33. Treated as variety of *Cypraea limacina* Lamarck.

34. I have seen 13 specimens mostly varying as follows: L, 14-18; BL, 66-73; HL, 53; LT, 17-20; CT, 16-18. All specimens are well separable from *Staphylaea semiplota* by their expanded and mostly suffused margins.

35. The first variety of *Cypraea staphylaea*, well described by Gray.

36. *Cypraea limacina* Lamarck.

37. British Museum (Natural History): pellucid, pale orange, base pale, extremities orange; the only specimen differs from *Staphylaea polita* in its straight aperture, and in the teeth, which are shorter than those of *S. limacina*, but not confined to the edge of the aperture in the second third of the shell. Hawaii.

38. Garrett's specimens probably belong to another species of the genus.

39. It seems not to be probable that the typical *Nuclearia nucleus* really occurs in the Hawaiian islands.

40. Schilder (Archiv für Naturgesch., vol. 91, pt. A-10, p. 148, note 287, 1927).

41. *Nuclearia madagascariensis* Gmelin.

42. Gray's identification of some shells as *Erronea caurica* Linnaeus and *E. cruenta* Gmelin has evidently been wrong.

43. British Museum (Natural History): 36 (54/43) 24:22, pellucid, base callous, Hawaii.

44. See page 19.

45. Gray's description of his "*fimbriata*?" evidently fits into the species described on page 19 as *Palmdusta waikikiensis*.

46. *Palmdusta fimbriata* Gmelin.

47. The study of more specimens from the Hawaiian islands proves that there is only one cylindrical species in the archipelago. Its fossula is very narrow and steep as in *Palmadusta marmorata* Schroeter from the Indian Ocean, but the Pacific shells are smaller (most of them 11 mm. to 12 mm. instead of 12 mm. to 14 mm.) and exhibit no spots on the margins. As *P. unifasciata* Mighels is described from Oahu, this name must be retained for the species from eastern Polynesia, while the species with distinctly concave fossula called *P. unifasciata* (Schilder: Zoolog. Anz., vol. 96, p. 67, 1931) becomes *P. minoridens* Melvill.

48. *Palmadusta microdon* Gray.

49. *Cribraria gaskoini* has often been confused with the pellucid variety of *esontropia* from Mauritius in the collections; there is a pellucid *esontropia* labeled "Hawaii" in the Sullioti collection, Museum of Genoa, but Sullioti's indications of habitat have often been incorrect.

50. *Cribraria esontropia* Duclos.

51. A shell from Maui (Dautzenberg collection, collected by Ancey) named *Cribraria fischeri* (11 (61/49) 17:15) is a dwarf *C. gaskoini*. The type of *C. fischeri* from Upolu (Vayssière collection) (13 (61/—) 17:15) has larger, not ringed ocelli on the dorsum and larger spots on the margins; it seems to be allied to *C. cribellum* Gaskoin. Both paratypes cited by Vayssière belong to *Erosaria labrolineata* Gaskoin (worn), as I stated when visiting Vayssière's collection.

52. Schilder (Jour. Conch., vol. 19, p. 169, 1931).

FAMILY ERATOIDAE

The five species of the subfamily Triviinae known from the Hawaiian islands can be distinguished as follows:

1. Globular, round like a pea, extremities blunt. 1. **Cleotrivia pilula**
Subrostrate to subcylindrical. 2
2. Dorsal sulcus distinctly impressed, ribs very fine; elongate, extremities less pronounced, posterior outlet never ear-shaped. 3
Dorsal sulcus entirely absent; or, if slightly impressed, the dorsal ribs are very coarse; subglobular, extremities subrostrate, posterior outlet encircled by the ear-shaped connection between both lips. 4
3. Dorsal sulcus very narrow, but long and usually entirely interrupting the ribs, DR very numerous; aperture less central, as the outer lip is rather narrow; inner lip rather truncate posteriorly; subcylindrical to elongate, extremities less produced. 2. **Trivirostra hordacea**
Dorsal sulcus rather broad, relatively short, mostly crossed by the ribs, DR less numerous; aperture rather central, inner lip acuminate posteriorly; elongate, subrostrate. 3. **Trivirostra edgari**
4. Dorsal sulcus absent, ribs fine; white. 4. **Trivirostra pellucidula**
Dorsal sulcus often impressed, ribs coarse; spotted with pink, spots mostly visible even in worn shells. 5. **Trivirostra exigua**

1. *Cleotrivia pilula* Kiener.

White, globular, extremities blunt, fossula hardly broader than the expanded columellar sulcus.

FF, 4 ×, much worn, dorsal sculpture not recognizable.

If compared with shells from the southern Pacific, the Hawaiian specimens are smaller and exhibit less numerous teeth on both lips:

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
FF	2.8	3.0	3.3	2.8	3.7	84	87	90	78	81	84	17	18	18	17	18	18	....	....	....	....	....	....
Pacific	2.9	3.4	3.8	2.7	4.6	87	89	91	77	79	80	20	21	22	18	19	20	47	51	55	29	31	33

2. *Trivirostra hordacea* Kiener.

White, characterized by the fine, very numerous ribs which are entirely interrupted by the long narrow dorsal sulcus in at least 70 per cent of the specimens, while in other shells the ribs cross the narrow sulcus, which very rarely (4 ×) becomes obsolete. Most specimens are very slender, but there are also stunted ones which are cylindrical though rather inflate. The general shape varies from cylindrical with blunt extremities and the hind top of the inner lip abruptly cut out so that the posterior outlet becomes better marked (α , typical *T. hordacea*), to subglobular with subrostrate extremities and the inner lip acuminate produced posteriorly in a way (variety β) which approaches *T. edgari*. Variety β is relatively gibbous, but there is no distinct difference in size or ribs.

PH, 49 × (all more or less cylindrical, only the typical form α collected); FF, 115 × (50 × are cylindrical, 65 × are subglobular or subrostrate, most specimens rather worn).

These shells are usually slightly smaller than the specimens from the Hawaiian islands preserved in various collections; specimens from the southern Pacific are still larger, and relatively less elongate, but there is no difference in the relative number of teeth and ribs:

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
PH	4.2	4.3	4.5	3.6	5.8	62	63	65	52	53	54	22	23	24	21	21	22	57	62	66	25	26	27
FF	3.9	4.1	4.4	3.3	5.9	63	64	66	50	52	54	22	23	23	20	21	21	58	59	61	24	25	26
Hawaii	4.1	4.6	5.1	3.6	5.8	62	64	66	52	53	54	22	24	26	20	21	22	56	59	62	26	28	30
Pacific	4.6	5.4	6.0	3.7	6.6	66	68	70	52	56	58	24	25	26	21	23	24	63	66	69	28	29	31

Although intermediate shells are more common than the extremes, α and variety β , their dimensions and number of ribs may be indicated separately:

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
α FF	3.9	4.1	4.5	3.4	5.2	63	64	65	50	51	52	22	22	23	20	21	21	58	59	61	24	26	26
β FF	4.0	4.1	4.3	3.3	5.9	64	65	66	55	56	57	22	23	24	19	20	21	58	59	61	22	24	26

3. *Trivirostra edgari* Shaw.

FF, 18 ×. Much-worn specimens are hardly separable from *T.*

hordacca variety β ; in *T. edgari* there are relatively more numerous labial teeth, but less numerous ribs; the chief difference consists in the dorsal sulcus.

The Hawaiian specimens are smaller and more elongate than the shells from the southern Pacific, and their labial teeth and marginal ribs seem to be relatively more numerous.

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
FF	4.0	4.2	4.6	3.8	5.2	64	65	67	53	55	57	24	24	25	20	21	23	55	58	60	20	22	24
Pacific	4.6	5.0	5.8	4.0	7.6	67	70	73	57	60	62	24	26	27	21	22	23	56	58	63	24	27	29

4. *Trivirostra pellucidula* Gaskoin.

PH, $5\times$; FF, $24\times$. The shells from PH are distinctly larger, with the extremities more produced, the teeth less numerous though the dorsum is more finely sculptured. Specimens from the southern Pacific are still much larger, stunted, and more coarsely ribbed:

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
FF	4.1	4.3	4.5	3.3	5.5	65	67	70	57	58	59	23	25	25	20	21	22	49	52	54	20	21	22
PH	4.5	4.7	4.9	3.9	5.3	65	66	67	55	56	56	23	24	25	19	20	22	53	57	61	24	25	26
Pacific	5.3	5.6	5.8	4.5	7.5	68	69	71	58	59	61	25	27	28	20	21	23	56	58	60	22	25	27

5. *Trivirostra exigua* Gray.

PH, $11\times$; FF, $15\times$. The shells from FF are more humped, but the slight differences in the number of teeth and ribs are probably only accidental. *T. exigua* from the southern Pacific is much larger, though a population ($49\times$) from Lifu, which I received from the Dautzenberg collection, Paris, approaches the mean of the Hawaiian shells. The pink markings and the number of teeth are identical.

	L			Mi Ma		BL			HL			LT			CT			MR			DR		
PH	3.9	4.0	4.1	3.2	4.5	68	70	71	59	61	62	18	20	21	16	17	18	44	47	48	16	16	18
FF	3.8	4.0	4.1	3.3	4.4	69	70	72	62	63	64	20	21	22	17	17	18	42	43	45	16	16	16
Lifu	3.9	4.1	4.3	3.2	4.7	..	..	..	..	..	..	21	21	22	17	17	18	..	..	..	..	..	..
Pacific	4.2	4.6	5.0	3.6	5.4	70	71	72	60	61	63	21	22	24	17	19	20	46	48	50	16	17	18

FAMILY CYPRAEIDAE

Mauritia maculifera Schilder.

Margins swollen, but rather angular, base flattened, teeth rather short, produced to one-fifth or one-sixth of the basal diameter only, anterior terminal ridge of the inner lip oblique; dorsum reticulate, lateral spots large, the dark blotch in the center of the inner lip always distinct. Rarely the lateral spots

are smaller, or confluent (a rather young shell) or both lips suffused with bluish.

FK, 9 ×. The Hawaiian specimens are extremely large, but otherwise typical; the following table contains the data from shells from the southern Pacific as well as the data of *Mauritia depressa* Gray, an allied species from the southern Pacific, similar in shape, but always smaller, with small lateral spots and no basal blotch:

	L	Mi Ma	BL	HL	LT	CT
FK, maculifera	69 70 71	62 72	65 67 68	52 53 53	29 30 31	25 27 28 ^a
Pacific, maculifera	49 58 66	38 78	66 68 71	50 51 52	28 30 32	23 24 26
Pacific, depressa	31 35 40	24 45	68 70 73	50 51 52	23 24 26	17 18 20

Mauritia scurra Gmelin.

PH, 32(49/41)40:29 and 40(53/45)40:28; PE, 43(51/43)39:33; LA, 52(55/46)42:30. The smallest specimen evidently belongs to the dwarf race *M. indica* Gmelin⁴; the other shells from PH and PE recall the intermediate variety common in the Malay Archipelago, while the shell from LA which is the largest *scurra* known at all, is evidently a typical *scurra*. The first-named specimen became subpellucid by being washed and bleached on the shore, while the three other shells are rather calcified. The following data may facilitate comparison of Pietschmann's shells with populations from the southern Pacific and from the Malay Archipelago:

	L	Mi Ma	BL	HL	LT	CT
Pacific, indica	28 30 32	25 35	48 48 49	37 38 39	37 39 40	27 28 30
Malay, indica	38 39 41	34 45	50 52 53	40 41 42	42 44 45	31 32 34
Pacific, scurra	45 45 45	42 51	53 54 56	42 43 45	44 45 46	30 31 33

Talparia talpa Linnaeus.

PH, 1 ×; LA, 4 ×. If compared with *talpa* from the southern Pacific and the Indian Ocean, and from the Malay Archipelago, the five Hawaiian shells are extremely large, broad, inflate, the teeth are rather coarse:

	L	Mi Ma	BL	HL	LT	CT
PH, LA	68 71 74	62 75	54 55 56	45 46 47	44 46 48	36 37 39 ^a
Pacific, Indian oceans	57 62 68	40 100	51 52 54	42 43 44	43 46 50	36 38 39
Malay Archipelago	51 54 58	43 66	53 53 54	43 44 45	41 43 45	32 34 36

^a A long, smooth accentuated rib between the terminal ridge and the first coarse columellar tooth in three specimens has not been included.

⁴ Schilder, F. A., Beiträge zur Kenntnis der Cypraea: Zoolog. Anz., vol. 92, p. 75, 1930.

⁵ Four to five and five to six denticles, which serrate the left wall of the posterior outlet in the Hawaiian specimens and in the shells from other countries respectively, have not been included.

The shell from PH is rather dark, base almost black, while the bleached shells from LA exhibit the dorsum almost white and the base reddish brown; but otherwise the specimens from both localities are identical.

Lyncina carneola Linnaeus.

Cylindrical, right margin thickened, slightly margined, but not expanded, aperture rather wide, outer lip subrostrate posteriorly; dorsum bleached, aperture purple.

FK, 77(59/49)33⁰:26. Such giants of *carneola* especially seem to occur in the eastern Pacific: a shell from Hawaii [Dautzenberg collection: 69(63/54)] and a shell from Tahiti [Museum Copenhagen: 89(57/49)46:33] are as large as a small collection of *carneola* from the Tuamotus (Vayssière collection), while the mean size of populations from Tjilatjap, Ternate, Kaju Ragi (Pleistocene of northern Celebes, studied by Schepman) and from other localities of the Malay Archipelago (all preserved in the Museum of Leiden) is much smaller, as it is also in the greyish race *crassa* Gmelin from Zanzibar and from the Red Sea:

	L			MI Ma		BL		HL		LT		CT					
Tjilatjap, <i>carneola</i>	25	28	35	19	51	59	62	64	50	51	53	25	26	28	19	21	23 ⁷
Ternate, <i>carneola</i>	28	31	33	25	41	58	59	60	48	49	50	25	26	27	19	20	21
Kaju Ragi, <i>carneola</i>	32	36	40	27	46	55	56	58	45	46	47	26	27	28	21	22	23
Malay, <i>carneola</i>	25	28	31	17	55	58	59	61	48	49	50	24	25	26	19	20	22
Zanzibar, <i>crassa</i>	24	25	27	20	32	62	63	65	49	50	51	23	24	25	18	19	20
Red Sea, <i>crassa</i>	22	25	29	18	41	61	65	66	49	52	54	21	23	24	18	19	20

Lyncina arenosa Gray.

Dorsum four-banded with reddish fulvous, margins reddish brown, striate, teeth and the two interior thirds of the base white, interstices of the fine columellar teeth brownish.

FK, 35(64/52)30⁸:23. Rather worn, but all chief characters are well recognizable. The shell is rather oblong, but it agrees otherwise with typical *arenosa* usually living in the Tuamotus:

	L			MI Ma		BL		HL			LT			CT			
Tuamotus	29	32	36	23	40	64	67	70	52	53	54	26	28	29	22	23	24

⁰ A small denticle on the base of the anterior outlet has been excluded.

⁷ One or two small denticles on the base of the anterior outlet, and one or two slight crenulations on the left wall of the posterior outlet have not been included; in 5 to 10 per cent of all *carneola* there is a small denticle intercalate behind the terminal ridge.

⁸ Two denticles on the base of the anterior outlet have not been included.

***Lyncina sulcidentata* Gray (fig. 1).**

Shell callous, teeth always thickened as in typical *sulcidentata*; on the base of the anterior outlet there are usually two small denticles well separable from the coarse labial teeth (they have been excluded in the table); the first columellar tooth which approaches the blunt terminal ridge is often rather smaller than the second tooth. Dorsum, if not worn, brownish grey with four distinct reddish brown bands (PH), rarely bluish grey with greyish brown bands (PE: 1 X), but never bright orange or fulvous as it is in the subpellucid variety *xanthochrysa* Melvill from Hawaii; margins greyish fulvous, finely punctate, base and teeth fulvous. Most specimens are worn and calcified: pale fulvous to brown, bands obsolete; when bleached practically colorless (FF).

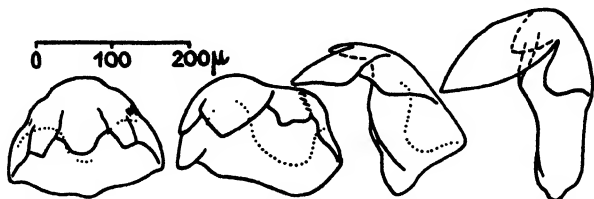


FIGURE 1. Half of row, radula of *Lyncina sulcidentata*.

Oliviform shells: fulvous, with four close brownish bands (23 mm.: PH). Young shells: bands reddish brown, protoconch and teeth white; spire slightly projecting, composing about 22 per cent of the diameter of the body whorl in each direction. Very callous adult shells exhibit the margins expanded and rather edged as it is in *Mauritia mauritiana* (25(74/61)24:17, PE). One shell from PH still contained remains of the animal: the radula (fig. 2: about 230 rows) is very similar to the other species of *Lyncina* so that Vayssi re's identification of a specimen without shell, the anatomy of which has been described by him,⁹ cannot be correct.

PH, 24 X; PG, 8 X; PE, 4 X; FF, 2 X; FK, 3 X; LA, 23 X.

There are striking differences in size between the populations collected by Dr. Pietschmann: the shells from LA are approximately as large as the specimens from Hawaii preserved in various collections, while the shells from PH, PG, and PE are extremely small and humped. The shell 59(68/55)28:24 from LA is the largest *sulcidentata* known at all.

	L			MI Ma		BL			HL			LT			CT		
PH, PG, PE	33	37	40	25	48	69	71	73	58	59	61	24	25	25	20	21	22
FF, FK	41	42	43	35	43	68	69	71	56	57	58	22	24	26	20	22	22
LA	42	46	50	36	59	69	72	75	56	57	60	26	26	28	22	23	24
Hawaii	42	45	50	30	55	68	70	72	55	56	57	25	27	28	22	23	25

⁹ Vayssi re, A., Recherches zoologiques et anatomiques sur les mollusques de la famille des Cyprac d s: Ann. Mus. Hist. Nat. Marseille, Zool., vol. 18, p. 75, pl. 11, figs. 157-161, 1923.

Basilitrona isabella Linnaeus (fig. 2).

PH, 35 ×; PS, 5 ×; PG, 15 ×; PE, 16 ×; LA, 3 ×; FK, 1 ×.
The length in millimeters of these shells varies as follows:

L	15	20	25	30	35	40	45
×	19	28	17	4	2	3	2

There are evidently two varieties, the common smaller form being the typical *isabella*, while the heavy, callous shells exceeding 32 mm. belong to the variety *controversa* Gray¹⁰. All shells collected in LA and FK are *controversa*; 1 × from PH and 2 × from PG also belong to *controversa* and are rather calcified, whereas the typical *isabella* from PH and PG are more or less bleached on the shore, but never calcified: therefore *controversa* evidently lives in different conditions.

The variety *controversa* is much larger, broader, higher, and more callous than the typical *isabella* from Pietschmann's collections, but the number of its teeth is increased only proportionately to the length of the shell,¹¹ and the percentage of specimens which show blackish spots in the red blotches of the extremities is very similar in both. *B. isabella* from Kaju Ragi (Pleistocene), Ternate, Tjilatjap, and from other localities of the Malay Archipelago, are intermediate in size, recall *controversa* in relative breadth and height, and exhibit finer, more numerous teeth and almost no dark spots on the extremities (see also fig. 2):

	L			Mi Ma		BL		HL		LT		CT			E
PH, <i>isabella</i>	17	20	23	12	31	48	50	51	38	39	41	27	29	31	91
PG, <i>isabella</i>	19	21	25	15	28	47	48	48	37	38	38	28	30	32	85
PE, <i>isabella</i>	17	20	22	15	27	48	49	51	38	40	42	26	28	30	82
PS, <i>isabella</i>	17	19	21	15	22	46	47	48	36	37	39	29	31	33	80
PH, PG, PE, PS, <i>isabella</i>	17	20	23	12	31	47	48	49	37	39	40	28	30	32	87
<i>Controversa</i>	37	40	44	33	46	54	55	56	45	46	47	38	39	40	71
Kaju Ragi, <i>isabella</i>	25	28	30	20	34	51	52	53	42	42	43	36	38	40	90
Ternate, <i>isabella</i>	27	28	30	22	34	53	54	55	44	45	46	35	38	39	39
Tjilatjap, <i>isabella</i>	27	29	32	19	36	55	56	58	46	47	48	36	38	41	12
Malay, <i>isabella</i>	22	24	27	16	38	53	54	56	44	45	46	33	35	37	19

Column E = percentage of specimens which show blackish spots in the red blotches of the extremities.

¹⁰ Schilder, F. A., Remarks on type specimens of some recent Cypraeidae: Malac. Soc. London, Proc., vol. 19, p. 56, 1930.

¹¹ Schilder, F. A., Die Korrelation zwischen Grösse und Zahnzahl bei den Cypraeacea: Arch. Zool. Italiano, vol. 16, p. 219, 1931.

¹² The inner margin of the fossula is adorned with distinct denticles; there are generally 6 to 8 teeth in Malayan shells, 6 or 7 in *isabella* from Hawaii, and 7 to 9 in *controversa*.

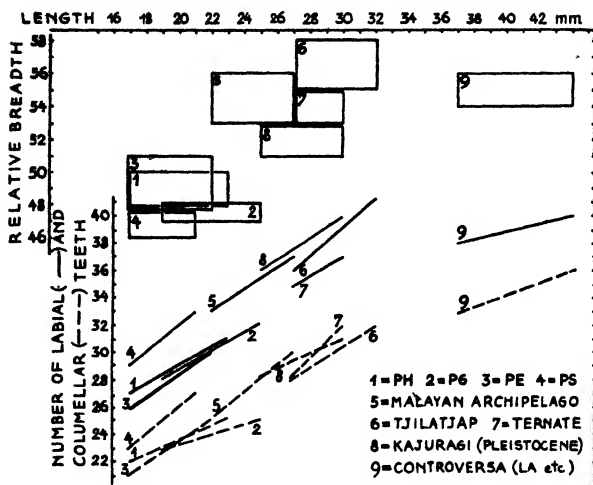


FIGURE 2. Variability of *Basilitrona isabella* Linnaeus: PH, Pearl and Hermes Reef; PG, Pearl and Hermes Reef, Grass Island; PE, Pearl and Hermes Reef, Southeast Island; PS, Pearl and Hermes Reef, Sand Island.

Pustularia tessellata Swainson.

PH, 35 ×; PG, 6 ×; PE, 5 ×; LA, 1 ×; FK, 1 ×. The specimens from PH, PG and PE are very similar in size, proportions, and denticulation, the only shell from FK does not exceed the extreme limits of these populations, while the shell from LA differs in its enormous size: it is the largest specimen of *tessellata* known at all. The *tessellata* preserved in various collections labeled as coming from Hawaii or Honolulu, are as broad as the shells from PH, but slightly larger:

	L			Ml Ma		BL			HL			LT			CT		
PH	23	24	27	20	32	69	71	73	54	55	56	25	26	27	20	21	22 ¹³
PG	25	28	30	23	35	69	69	70	53	55	57	26	28	30	21	22	23
PE	25	28	31	24	34	64	68	72	53	55	57	26	27	28	21	22	23
FK	....	24	....	....	....	....	64	....	....	55	....	....	28	....	....	21	....
LA	....	42	....	....	....	....	71	....	....	57	....	....	37	....	....	32	....
Hawaii	27	31	34	19	36	70	72	75	55	56	57	26	29	31	23	25	27

¹³ The fossula exhibits 3 to 5, mostly 4 teeth interiorly, which are not placed on the margin itself but at a short distance towards the concavity, as it is in *Pustularia cicercula* too. These teeth are well developed also in rather young shells.

In fresh shells the dorsal bands are brown, the lateral spots dark brown to almost black, in close relation to the pale basal zones. The anterior extremity is adorned by a small tubercle dorsally, which is better marked in slightly worn specimens because it becomes whitish. The diameter of the spire is about 26 per cent of the body whorl in each direction. Young shells exhibit three brown bands, but no lateral spots, the nucleus of the spire is brown, the following whorls are pale, the suture of the body whorl is accompanied by a darker brown zone (PE). The only specimen from FK is subpellucid, unspotted white, shining though evidently bleached, teeth white. The giant shell from LA has rather short extremities and the aperture rather curved posteriorly. In the shells from PH there is some variability in the thickening of the margins and in the rostration of the extremities, well indicated by the indices BL and HL respectively, in one shell (25(77/58)24:17) the thickened margins are suffused with greyish callus which makes the lateral blotches almost invisible.

Ravitronea caputanguis Philippi.

PH, 1 ×; FK, 7 ×; LA, 2 ×. If compared with *caputserpentis* Linnaeus *caputanguis* is more humped (though the margins often are expanded in a similar way), it exhibits slightly more numerous teeth, the interstices of which are distinctly tinged with reddish brown; the inner margin of the fossula usually exhibits three small denticles instead of two denticles in *caputserpentis*. The specimens from PH, FK, and LA seem to be identical; they also agree with *caputanguis* from Hawaii, Japan, and eastern Australia in all characters, though they are smaller and relatively broader. The dorsal spots are of different size, larger ocelli being surrounded by smaller spots, margins angular, greyish brown to very dark, base rather convex, the central third whitish, the interstices of the teeth mostly distinctly chestnut. The following table also indicates the data of *caputserpentis* from Ternate, Tjilatjap, other Malayan localities, and the data of all *caputserpentis* without locality known to the writer.

	L			MI Ma		BL		HL		LT		CT					
PH, FK, LA, caputanguis	25	28	31	23	35	74	76	80	49	50	51	16	18	19	14	14	15
Hawaii, Japan, caputanguis	30	32	34	26	37	69	72	75	49	51	53	18	19	19	13	14	15
Australia, caputanguis	30	31	34	23	43	69	70	71	49	50	51	16	17	18	13	14	15
Ternate, caputserpentis	25	26	27	22	32	74	76	77	48	49	50	16	16	17	12	13	13
Tjilatjap, caputserpentis	30	31	32	27	35	73	75	76	47	48	49	17	18	19	13	13	14
Malay, caputserpentis	29	30	32	25	35	73	74	76	48	48	49	17	17	18	13	13	14
No locality, caputserpentis	26	29	33	15	43	72	75	78	47	48	50	16	17	18	13	14	15

Erosaria helvola (Linnaeus) **hawaiiensis** Melvill.

All specimens of *helvola* I have ever seen credited to the Hawaiian islands exhibit the margins suffused with pinkish flesh color varying to pinkish fulvous and pale straw color or even white, while in all shells of *helvola* from the Indian and Pacific Oceans (the Hawaiian islands excluded) the margins are reddish brown varying to fulvous and chestnut. In all Hawaiian specimens the reddish brown color is confined to the aperture, if it is not entirely wanting; the extremities are more bluish lilac or whitish than pinkish lilac. Therefore the Hawaiian shells evidently must be separated as local subspecies, at least, called *hawaiiensis* by Melvill (1888) and—a pale variety?—*ostergaardi* by Dall (1921).

PH, 47 ×; PG, 6 ×; PE, 6 × FK, 1 ×; LA, 1 ×. Among the shells from PH are four specimens which are not fresh or simply worn, but also bleached, as are the specimens from FK and LA, too; they evidently came from other environments. Their size is relatively enormous: 23, 24, 26, and 28 mm. The other shells from PH and those of PG are slightly smaller than the shells from PE, FK and LA; the specimens from PE are relatively slender and exhibit less numerous teeth; the few specimens from PG are rather humped. If compared with *hawaiiensis* from Honolulu and Hawaii (preserved in various collections), Dr. Pietschmann's shells are slightly larger, relatively broader and higher; the table contains also populations of typical *helvola* from the southern Pacific, from the Malayan Archipelago, from the Indian Ocean (mostly without exact locality) and from Durban (Natal) for comparison:

	L			Mi Ma		BL			HL			LT		CT	
PH, <i>hawaiiensis</i>	18	21	23	15	28	68	72	75	51	51	52	16	17	18	13 14 15
PG, <i>hawaiiensis</i>	19	21	22	18	23	69	73	77	51	55	59	17	18	19	14 15 16
PE, <i>hawaiiensis</i>	20	23	26	18	27	66	69	72	50	51	52	16	18	18	13 15 16
FK, <i>hawaiiensis</i>	....	23	....	....	....	....	65	....	....	52	....	....	20	....	.... 14
LA, <i>hawaiiensis</i>	....	23	....	....	....	....	72	....	....	53	....	....	16	....	.... 14
Hawaii, <i>hawaiiensis</i>	17	19	20	15	30	64	67	70	48	50	51	16	17	18	13 14 15
Pacific, <i>helvola</i>	15	17	18	14	19	65	67	72	49	50	52	15	16	17	13 13 14
Malay, <i>helvola</i>	17	18	20	14	24	67	70	73	50	51	52	16	16	18	13 13 14
Indian Ocean, <i>helvola</i>	18	20	23	12	34	62	64	68	49	50	51	16	18	19	14 15 16
Natal, <i>helvola</i>	21	23	24	18	28	65	67	70	49	51	53	17	18	19	14 14 15

In 30 specimens the dorsal color is well recognizable: it varies from fulvous (10 per cent) to chestnut (37 per cent), greyish brown (23 per cent) and greenish grey (30 per cent). In 40 per cent the brown dorsal spots are scattered, in 47 per cent they cover about the

same area as the white ocelli, and in 13 per cent the brown spots predominate or are even confluent. This percentage 40:47:13 is altered in *hawaiiensis* from Hawaii into 17:83:0, in *helvola* from the Pacific into 57:43:0, in *helvola* from the Malayan Archipelago into 33:50:17, in *helvola* from the Indic into 28:51:21, and from Natal into 0:10:90.

There are 3 to 5 denticles on the inner margin of the fossula, as there are in the populations from Hawaii and from the Malayan Archipelago, too. Young shells are blue grey, with one or three brown bands of various intensity, suture whitish, the slightly projecting protoconch lilac to purple; the diameter of the spire is about 24 per cent of the body whorl in each direction. The radula of *hawaiiensis* from PH does not exhibit any difference from typical *helvola*.

Staphylaea semiplota Mighels.

Dorsum smooth, in fresh specimens blackish brown, with numerous white spots, extremities orange, lateral pittings chestnut, base white, teeth lined with orange, columellar teeth very short in the central third, but elongate anteriorly and posteriorly; when worn, the dorsum is reddish brown, pittings orange. Young shells are greyish brown, top of the spire chocolate, spots confined to the margins.

PH, 41 ×; PS, 1 ×; PG, 14 ×; PE, 3 ×; LA, 1 ×. One shell from PH is subpellucid, but not subrostrate as is *polita* Roberts; the specimen from LA recalls the latter species in shape, but is not transparent. If compared with *semiplota* from Hawaii and eastern Polynesia, the shells from the western islands visited by Dr. Pietschmann are much larger, but the general shape, and the number of teeth correspond to the increased length; the populations from PH, PS, and PE are practically identical; the shells from PG are slightly larger and possibly broader; the unique shell from LA is a giant, as it is in other species from LA, too.

	L	Ml Ma	BL	HL	LT	CT
Hawaii, Polynesia	9 9.5 10	8 15	58 58 61	47 48 49	17 17 18	13 14 15 ¹⁴
PH, PS, PE	13 14 15	9 23	57 58 60	45 47 48	18 19 19	15 16 17
PG	14 15 16	12 20	57 59 61	46 47 48	19 20 21	16 17 18
LA	19	..	56 ..	45	21	19

Nuclearia honoluluensis Melvill.

PH, 5 ×; PG, 1 ×; PE, 1 ×. Rather worn, so that the shells are uniformly pale grey or pinkish, in one specimen the reddish lines,

¹⁴ In the space behind the anterior columellar ridge, in 63 per cent of specimens there is a less accentuated smaller rib (not included in the number of columellar teeth), rarely there are 2-3 ribs or no rib. The fossula usually exhibits 5-6 denticles interiorly.

which surround the dorsal tubercles and the basal ribs, are visible. If compared with the well-known *honoluluensis* from the larger eastern Hawaiian islands, the shells from PH, PG, and PE are smaller, more depressed [one shell from PH is extremely depressed: $26(70/42)21:13 + 6$], but similar in dentition, even in the number of finer intercalate ribs (IR), which start from the outer margin of the inner lip and reach the aperture, where they are well separable from the coarse primary ribs. The table also contains the data of *N. nucleus* Linnaeus from various localities of the Indian and Pacific Ocean for comparison. *N. nucleus* can easily be distinguished by the acuminate extremities, the more numerous labial teeth and the wanting of the intercalate columellar ribs, which almost never reach the aperture, whenever they are present.

	L	Mi Ma	BL	HL	LT	CT ¹³	IR
Hawaii, honoluluensis	25 30 34	21 38	62 67 70	44 45 46	23 24 25	13 14 16	6 6 7
PH, PG, PE, honoluluensis	23 26 29	18 31	65 67 69	42 43 45	20 21 23	12 13 14	6 6 7
Nucleus	18 19 22	11 28	60 62 63	48 50 52	24 25 26	15 16 17	.. ..

In only 8 per cent of all shells investigated by the writer there are one or two IR.

Talostolida rashleighana Melvill.

Adult specimen much worn, depressed, margins angularly expanded, left margin bent upward, extremities also margined and expanded, dorsally callous; fossula and columellar sulcus equally broad in their entire length; dorsum pinkish lilac, with brown interrupted bands, the two central ones almost confluent, margins with 38 and 28 rather large dark spots which extend as far as two-thirds of the dorsal surface. The young shell is colored in the same way, but there are only 14 smaller spots on the right margin which is not yet margined; it seems to be similar to *T. teres* Gmelin, but is more humped.

PH, $27(61/48)23:23$ (young). FK, $33(63/44)23:20$ (adult). The following table contains the data of *rashleighana* from Hawaii from several collections and of *teres* from localities of the Pacific and Indian Oceans:

	L	Mi Ma	BL	HL	LT	CT
Rashleighana	22 24 29	15 32	62 64 66	47 49 50	19 20 22	17 19 21
Teres	22 26 29	16 37	53 54 55	42 43 44	22 23 26	21 23 25

¹³ A smaller rib intercalate in the space behind the slit terminal ridge and 1-3 oblique ribs on the hind top of the inner lip are not included.

***Palmadusta unifasciata* Mighels.**

Subcylindrical, aperture straight, outer lip sinuous anteriorly, but not projecting posteriorly, inner lip slightly swollen on its posterior top, anterior columellar teeth much coarser than the posterior ones, fossula narrow, steep, not concave, the columellar teeth extending to its inner margin hardly compressed, columella smooth posteriorly; formerly greyish blue, now worn, pinkish lilac, with an interrupted brown central band, margins white, unspotted, extremities with four pink spots.

PH, 1 ×; PG, 4 ×; PE, 1 ×. The specimens from PH, PG, and PE are smaller and more inflate than *unifasciata* from the southern Pacific, but the relative number of teeth is identical; the still smaller *P. minoridens* Melvill from Lifu has relatively more numerous teeth and a broader fossula with the inner margin distinctly produced.

	L			MI Ma		BL			HL			LT			CT		
Pacific, <i>unifasciata</i>	11	12	12	9	14	52	53	54	42	43	44	17	17	18	16	17	19
PH, PG, PE, <i>unifasciata</i>	9	10	11	8.5	12	55	57	58	43	44	45	15	16	17	13	15	17
Lifu, <i>minoridens</i>	8.5	8.5	9	7.5	10	53	54	54	42	43	43	18	18	19	17	19	20

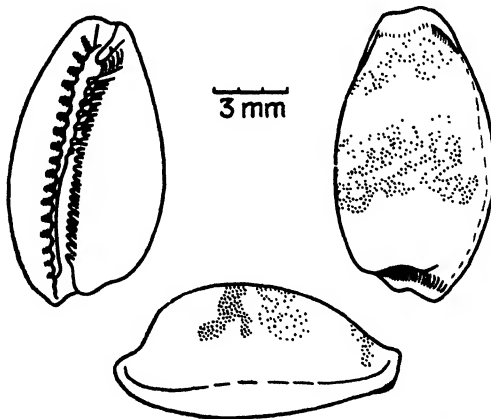


FIGURE 3. *Palmadusta waikikiensis*, new species.

***Palmadusta waikikiensis*, new species (fig. 3).**

Subpyriform, outer lip distinctly margined, base convex, aperture slightly curved, anteriorly dilatate, outer lip projecting posteriorly, labial teeth rather coarse, columellar teeth very fine anteriorly and extremely fine posteriorly, fossula narrow, very shallow, but distinctly projecting interiorly; subpellucid, whitish, with a rather broad and interrupted fulvous central band and a second narrower band anteriorly, margins and base white, extremities unspotted.

Type from Honolulu (writer's collection, no. 2754): 12(55/45)-18:21 (fig. 3). Paratype from Waikiki (Museum Leiden, collected by Heurn): 15(53/42)19:23, rather calcified.

Differs from all allied species by the columellar teeth, which are more numerous than the labial ones. *Palmadusta waikikiensis* is more pyriform than *P. unifasciata*, it has finer teeth than *P. fimbriata*, and a less concave fossula than *P. minoridens*; its right margin recalls *P. microdon*, but *P. waikikiensis* has coarser labial teeth and a much narrower fossula.

DISTRIBUTION

Table 2 shows the number of specimens collected in the several islands.

Table 2. Numerical Record, Pietschmann Collection

		PH					
	FF FK LA	Entire	PHN	PG	PE	PS	
1. Cleotrivia pilula.....	4	....	....	....	....	....	....
2. Trivirostra hordacea							
(α = typical)	50	....	49	49	....	....	....
2a. Trivirostra hordacea variety β	65	....	....	....	....	....	....
3. Trivirostra edgari	18	....	....	....	....	....	....
4. Trivirostra pellucidula	24	....	5	5	....	....	....
5. Trivirostra exigua	15	....	11	11	....	....	....
6. Mauritia maculifera	9	....	....	....	....	....	....
7. Mauritia scurra (typical).....	....	1	....	....	....	....	....
7a. Mauritia scurra indica.....	....	3	2	....	1	....	....
8. Talparia talpa .....	....	4	1	....	....	....	....
9. Lyncina carneola	1	....	....	....	....	....	....
10. Lyncina arenosa	1	....	....	....	....	....	....
11. Lyncina sulcidentata	5	23	36	24	8	4	....
12. Basilitronea isabellana (typical).....	....	....	68	34	13	16	5
12a. Basilitronea isabellana controversa..	1	3	3	1	2	....	....
13. Pustularia tessellata	1	1	46	35	6	5	....
14. Ravitronea caputanguis	7	2	1	1	....	....	....
15. Erosaria helvola hawaiiensis.....	1	1	59	47	6	6	....
16. Staphylaea senegalota .....	..	1	59	41	14	3	1
17. Nuclearia honoluluensis .....	....	....	7	5	1	1	....
18. Talostolida rashleighana	1	....	1	1	....	....	....
19. Palmadusta unifasciata .....	....^a	....	6	1	4	1	....
19 species and 3 varieties.....	203	36	355	258	54	37	6

FF, French Frigates Shoal; FK, French Frigates Shoal, King Island; LA, Laysan Island; PH, Pearl and Hermes Reef; PHN, Pearl and Hermes Reef, no particular island; PG, Pearl and Hermes Reef, Grass Island; PE, Pearl and Hermes Reef, Southeast Island; PS, Pearl and Hermes Reef, Sand Island.

The distribution of the Eratoidae (Triviinae) does not indicate any peculiarity. With regard to the Cypraeidae, however, it is evident that the relatively large or callous species (6, 7, 8, 9, 10, 12a, 14) have been collected chiefly in French Frigates Shoal and in Laysan Island, whereas the smaller, less callous, or finely sculptured species (7a, 12, 13, 15, 16, 17, 18, 19) occur chiefly in Pearl and Hermes Reef. This striking difference in the population indicates ecological differences of these islands. *Lyncina sulcidentata* seems to live equally well in both environments. On the other hand, there is no difference between the several islands of Pearl and Hermes Reef; the relative number of specimens of each species corresponds rather to the total number of shells collected in PH, PG, PE, and PS.

The average length of the shells is given in Table 3.

Table 3. Average Length of Shells, Pietschmann Collection.

Expressed in per cent of the usual length of specimens from other regions (marked by an asterisk).

	Pacific	Hawaii	FF FK	LA	PH Entire
1. <i>Cleotrivia pilula</i> .....	*	....	88	....	....
2. <i>Trivirostra hordacea</i>	*	86	76	....	80
3. <i>Trivirostra edgari</i> .....	*	....	84	....	....
4. <i>Trivirostra pellucidula</i> ..	*	....	77	....	84
5. <i>Trivirostra exigua</i> .....	*	....	87	....	87
6. <i>Mauritia maculifera</i> .....	*	....	121	....	....
7. <i>Mauritia scurra</i> and <i>indica</i>.....	*	....	....	116	106
8. <i>Talparia talpa</i> .....	*	....	....	115	....
9. <i>Lyncina carneola</i>	*	(223)	(248)	....	....
10. <i>Lyncina arenosa</i> .....	*	....	(121)	....	....
11. <i>Lyncina sulcidentata</i> .....	....	*	94	102	82
12. <i>Basilitronea isabella</i> .....	*	....	....	....	74
12a. <i>Basilitronea isabella controversa</i>	*Type	....	( 87)	116	100
13. <i>Pustularia tessellata</i> .....	....	*	( 77)	(135)	81
14. <i>Ravitronea caputanguis</i>	*	103	93	(91)	(96)
15. <i>Erosaria helvola</i> and <i>hawaiiensis</i> ..	*	95	(115)	(115)	105
16. <i>Staphylaea semiplota</i> .....	*	....	....	(211)	147
17. <i>Nuclearia honoluluensis</i> .....	....	*	....	....	87
18. <i>Talostolida rashleighana</i> .....	....	*	(125)	....	(113)
19. <i>Palmadusta unifasciata</i> .....	*	....	....	....	83

All Eratoidae are relatively small; the Cypraeidae from Pearl and Hermes Reef are of medium size to small, or if larger they are always surpassed by the specimens from French Frigates Shoal and from Laysan Island, where most species become large to gigantic.

Therefore the conditions of French Frigates Shoal and especially of Laysan Island are evidently favorable to the development of callous species and of large individuals of other species, whereas most Cypraea from Pearl and Hermes Reef are rather small, but otherwise do not exhibit any peculiarity.

**LYSIMACHIA, LABORDIA, SCAEVOLA,
AND PLUCHEA**

HAWAIIAN PLANT STUDIES—I

By

HAROLD ST. JOHN

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LYSIMACHIA, LABORDIA, SCAEVOLA, AND PLUCHEA

Hawaiian Plant Studies—I

By HAROLD ST. JOHN

INTRODUCTION

This is the first paper in a projected series of studies of Hawaiian vascular plants. The plan is to publish descriptions of new species or other new plants, to present brief revisions of plant groups, to record notable extensions of ranges, to list the collection of recent adventives, and to put on record ecological observations. These items will be assembled and issued as numbered parts under the general title, "Hawaiian plant studies."

FAMILY PRIMULACEAE

Lysimachia Forbesii Rock, Fedde Rep., vol. 13, p.361, June 30, 1914.

Lysimachia longisepala Forbes, B. P. Bishop Mus., Occ. Papers, vol. 4, no. 3, p. 46, 1909; not *L. longisepala* Forrester, Royal Bot. Gardens Edinburgh, Notes, vol. 19, p. 237, 1908.

Lysimachia koolauensis Forbes, B. P. Bishop Mus., Occ. Papers, vol. 6, no. 1, p. 39, 1914.

Mr. Forbes inadvertently chose for his new and very distinct species a name that was already preoccupied. As soon as this earlier homonym appeared in the next supplement of the "Index Kewensis," the duplication was discovered by both Mr. Forbes and Prof. Rock. Each renamed the Hawaiian plant, and their two specific names were both published during 1914. *Lysimachia Forbesii* Rock was published on June 30, 1914. *Lysimachia koolauensis* was not dated more exactly than "1914." It was appended to the "Director's report for 1913," which bears the statement, "Presented to the Trustees February 17, 1914; returned to the Director April 24, 1914, with orders to omit everything but 'work accomplished.'". Hence it is obvious that Forbes' publication must have been printed and issued somewhat later than April twenty-fourth. A search was recently made for the precise date of publication. Most of the principal libraries in Honolulu have several copies of this publication. These copies either lack any date of receipt stamp or have had their covers discarded before being bound. Inquiries sent to several of the leading libraries in the western United States revealed the same

conditions. However, Dr. W. L. Jepson has kindly informed me that the copy in the library of the University of California at Berkeley is stamped as received on July 27, 1914. One, or at most, two weeks could be allowed for the time the paper was in the mail between Honolulu and Berkeley. Definite evidence on the actual date of publication was finally obtained from the records of the Bishop Estate and from those of the Paradise of the Pacific, the printer. The pamphlet was printed on July 15, 1914. Thus, *Lysimachia Forbesii* Rock is the earlier, hence, the valid name for the plant.

FAMILY LOGANIACEAE

Labordia hypoleuca Degener, Flora Hawaiiensis, Family 302, August 10, 1932.

Shrub 2-3 meters tall; young branches green, fleshy, terete, granular puberulent or appressed pilosulous; youngest nodes gelatinous; branches stout, the bark becoming smooth and brown; innovations from the uppermost axils below the inflorescence; leaves opposite; stipules united into a sheath, 3-6 mm. long, remotely ciliate, membranous, pointed or emarginate midway between the petioles; the leaf axils with many subulate glands 0.6-0.8 mm. long, white, but blackening on drying; petioles green, 1-5 cm. long, 3-8 mm. in diameter appressed pilosulous; blades 7-26 cm. long, 2-14.5 cm. wide, broadly elliptic to ovate-elliptic, cuneate at base, short acuminate at tip, nearly glabrous and dark glossy green above, below whitish, and appressed pilosulous, principal lateral veins 7-13 on a side, curved towards apex; inflorescence a terminal 2-forked, 8-82-flowered cyme, the branches recurved, 1-4 cm. long; branches of the inflorescence and pedicels appressed whitish pilosulous; bracts 3-6 mm. long, linear, white pilosulous; flowers sessile or on pedicels 1-17 mm. long, thickened towards the tip; sepals 5-6, 6-11 mm. long, pale green, lanceolate, acuminate, unequal, pilosulous, the tips somewhat convolute; corolla in bud convolute, the lobes closed to the apex; corolla pale greenish yellow, shading to whitish at base, 26-37 mm. long, glabrous or slightly pilosulous without, within the tube and the base of the lobes sparsely pilosulous, the tube cylindric, 3-5 mm. in diameter, 15-23 mm. long, the five lobes 8-13 mm. long, reflexed, linear-lanceolate; anthers 3-4 mm. long, lanceolate, pale yellow, attached from their median points to the base of the sinus of the corolla lobes, the tip of the anthers with a stout ovate apiculation, the base cleft one-quarter of the length; pistil about 2 cm. long; ovary subulate, gradually tapering above, with a hispid band just above the middle; style glabrous, about 4 mm. long; stigma 7 mm. long, clavate, 2 mm. in diameter, green, and white hispidulous especially towards the tip, and towards the tip often with a faint crease; cells of the ovary 2; ovules numerous; capsules 18-50 mm. long, 8-12 mm. in diameter, spindle-shaped, terete or nearly so, the acute beak flattened perpendicular to the septum and extending 5 mm. or more beyond the tip of the locules, the dehiscence loculicidal from the tip or from both the tip and the base; seeds embedded in a yellowish pulp; seeds 2.5-3.5 mm. long, asymmetrically ovoid,

white or pale brown, the testa with a conspicuous, light, cellular network, the hilum linear, nearly as long as the flattened side of the seed.

Originally described by Mr. Degener from a single collection made at Punaluu-Kaluanui in June, 1932. This collection contains good flowers and foliage, but only immature fruit. His description does not include the range of variation of most of the parts, nor is there any statement of the differences between the new *L. hypoleuca* and related species.

Abundant material of this species exists, and it was used in the preparation of the description here presented. This, under a manuscript specific name, was submitted for and awaiting publication previous to the publication of *L. hypoleuca*. The first collection, made in 1908 by C. N. Forbes, is available in Bernice P. Bishop Museum. Others, assembled by me and by my students, had not been mounted and made available. On the basis of this material it has seemed desirable, even now, to publish the foregoing amplified description, to list additional collections and localities, and to contrast the species with its nearest relative.

Hawaiian islands: Oahu, shrub, 8 feet tall, wet wooded slope, 1600 feet altitude, Waikakalaua Gulch, Koolau mountains, April 6, 1930, Harold St. John no. 10464, in flower; same locality, in fruit, September 14, 1930, H. St. John and E. Y. Hosaka no. 10567; Koolau mountains between Punaluu and Kaipaupau, November 14-21, 1908, C. N. Forbes; shrub, 10 feet tall, in small wet valley, near trail, 1800 feet altitude, Kaluanui-Punaluu Divide, Kaluanui, Koolau mountains, May 8, 1932, E. P. Hume no. 558.

Dr. Hillebrand¹ divided the species of *Labordia*, an endemic Hawaiian genus, into two sections, *Labordeae verae* and *Geniostomoideae*. His description of each is lengthy, but lacking in tangible, contrasting characters. The new species here discussed agrees with the *Labordeae verae*, except that the convolute petal lobes are appressed in the bud and the flowers are pale greenish yellow. H. Sollereder² followed Hillebrand's division of the species into the two groups, but did not use the sectional names. I consider that the characters of *Labordia hypoleuca* invalidate the two sections and that they had better be abandoned.

¹ Hillebrand, William, *Flora of the Hawaiian islands*, pp. 288-289, Heidelberg, 1888.

² Engler, A. und Prantl, K., *Die natürlichen Pflanzenfamilien*, ed. 1, Teil 4, Abt. 2, p. 32, Leipzig, 1895.

Labordia hypoleuca Degener is distinguished by having the young stems, foliage, and inflorescence appressed white pilosulous; the corolla tube 15-23 mm. long, glabrous or slightly pilosulous without, pilosulous within; and the capsules 8-12 mm. broad, spindle-shaped, terete or nearly so. It grows on both slopes of the Koolau Range, at Waikakalaua Gulch on the lee slope of the central part of the Koolau Range, and at Punaluu, further west and on the windward slope. The most similar species is *L. membranacea* Mann. This differs by having the young stems, foliage, and inflorescence dark rufous hispidulous; the corolla tube 10-14 mm. long, glabrous; and the capsules 15-18 mm. broad, oval, strongly flattened parallel to the backs of the two valves. This older species grows on the lee slopes of the Koolau mountains from Nuuanu Valley eastward.

The generic name is intentionally spelled *Labordia*, with an *i* instead of an *e*. This follows the original spelling, and is in accord with the usage of Bentham and Hooker, of Engler and Prantl, and of Rock.

FAMILY GOODENIACEAE

Scaevola Skottsbergii, new species (pl. 1; fig. 1).

Shrub, 2-3 meters tall, with numerous ascending branches; stems pale brown, glabrate; branchlets green, ascending or appressed short pilosulous, leafy for 1-2 dm.; leaves alternate; petioles 1-2.5 cm. long, more or less winged nearly to the base, ascending pilosulous; blades 3-8 cm. long, 15-34 mm. wide, firm membranaceous, elliptic, slightly asymmetric and curved, upper side clear green, thinly appressed pilosulous but in age almost glabrate, lower surface somewhat paler green, densely and permanently appressed pilosulous, midrib strong, straight in the lower half, often staggered in the upper half, principal lateral veins usually 5-7 on a side, arched-ascending, the margin entire in the lower third, in the upper two-thirds with 6-12, usually 8-9, prominent, irregular, apiculate serrations, base of the leaf cuneate, decurrent, the tip subacute, apiculate; flowers much shorter than the leaves, numerous, often each leaf axil producing a 1-flowered pedicel; pedicels slender, 5-27 mm. long, ascending pilosulous, 1-flowered (a single example that was 2-flowered on one pedicel was noted); bracts beneath the ovary 2, linear, pilosulous, often unequal, 5-18 mm. long, usually deciduous from the ripe fruit; ovary 3-4 mm. long, cylindric, green, glabrous; calyx a short collar, irregularly shallowly lobed, pilose ciliate; corolla pilosulous above the middle, whitish, the nerves dull lavender; corolla-tube 15-17 mm. long; corolla-lobes 11-14 mm. long, with delicate, membranous wings that are easily ruptured; style 26 mm. long, pilose, scarcely so for a short distance below the densely pilose swollen tip; stamens 12-14 mm. long, anthers 4 mm. long; berry ellipsoid to ovoid, purplish black, glabrous, polished and shining, 10 mm. long, 7-8 mm. in diameter; calyx-lobes pilose ciliate,

hypanthium pale, yellowish, granular, pilose near the style-scar; stone ovoid, scarcely compressed, brownish, nearly smooth, or sparsely rugose, 5-5.5 mm. long, 2.8-3.2 mm. wide, 2-celled, 2-seeded.

Frutex 2-3 m. altus ramosus, caulibus pilosiusculis viridibus deinde brunneis glabratisque, foliis alternis, petiolis 1-2.5 cm. longis alatis pilosiusculis, laminis 3-8 cm. longis, 15-34 mm. latis membranaceis ellipticis leviter inaequalibus curvatisque, paginis superioribus viridibus sparse adpressi-pilosiusculis deinde glabris, paginis inferioribus pallidi-viridibus crebiter adpressi-pilosiusculis, costis validibus ad basim rectis ad apicem fluctuatis, nervis 5-7 utrinque arcuatis, marginibus integris in tertia parte ad apicem 6-12-plerumque 8-9-apiculati-serratis, ad basim cuneatis decurrentibus, apice subacuto apiculato, floribus singulis in axilibus quam folias valde brevioribus, pedicelis gracilibus 5-27 mm. longis pilosiusculis unifloriferis, bracteis 2 linearibus pilosiusculis 5-18 mm. longis saepe inaequalibus vulgariter deciduis, ovariis 3-4 mm. longis cylindricis viridibus glabris, calycibus brevibus breviter lobatis pilosi-ciliatis, corollis albescentibus pilosiusculis supra mediam nervis violaceis, tubo 15-17 mm. longo, lobis 11-14 mm. longis molliter alatis, stylis pilosis 26 mm. longis, staminibus 12-14 mm. longis, antheris 4 mm. longis, drupis ellipsoideis vel ovatis purpureo-atris glabris lucidis 10 mm. longis 7-8 mm. latis, hypanthiis pallidis luteis granularibus in centro pilosis, endocarpiis ovoideis brunneis 5-5.5 mm. longis 2.8-3.2 mm. latis, loculis 2 uterque 1-semeniferis.

Hawaiian islands: Oahu, 6-foot shrub in thicket on steep slope, Kipapa Gulch, 800 feet altitude, Waipio, February 21, 1932, Harold St. John no. 11562 (type in B. P. Bishop Museum).

I am somewhat in doubt as to to which section of the genus this new species should be referred. The recent systematic treatments of the genus follow closely the division into sections proposed by G. Don. The characterizations of several of them are so nearly identical and so lacking in any tangible differentiating characters, that I cannot escape the feeling that they are either very poorly characterized or else very artificial.

As customarily defined, as in, for instance, the monograph by Krause,³ *S. Skottsbergii* must certainly be assigned to the section *Crossotoma*, even though its branches do not become thorns. In this section the most similar species is *S. tomentosa* Gaudichaud of West Australia. This species has stems as much as 8 dm. in height; a coat of more or less dense stellate pubescence; the leaves obovate or obovate-oblong, rarely subobovate, the apex obtuse, and with the petiole up to 4 cm. in length and 0.8-1.4 cm. in width; the peduncles with two large leafy ovate or ovate-oblong bracts fused on one side up to the middle; the corolla reddish brown without and densely tomentose, within orange, 1.8-2.3 cm. long and gibbous at base.

³ Krause, K., Goodeniaceae: Pflanzenreich, vol. 4, fam. 277, pp. 118-119, 1912.

On the contrary, *S. Skottsbergii* St. John has stems from 20-30 dm. in height; a surface more or less pilosulous throughout; the leaves elliptic, slightly asymmetric and curved, the apex subacute, apiculate, and the blade with the petiole up to 9.5 cm. in length and 1.5-3.4 cm. in width; the peduncles with two linear distinct bracts; and the

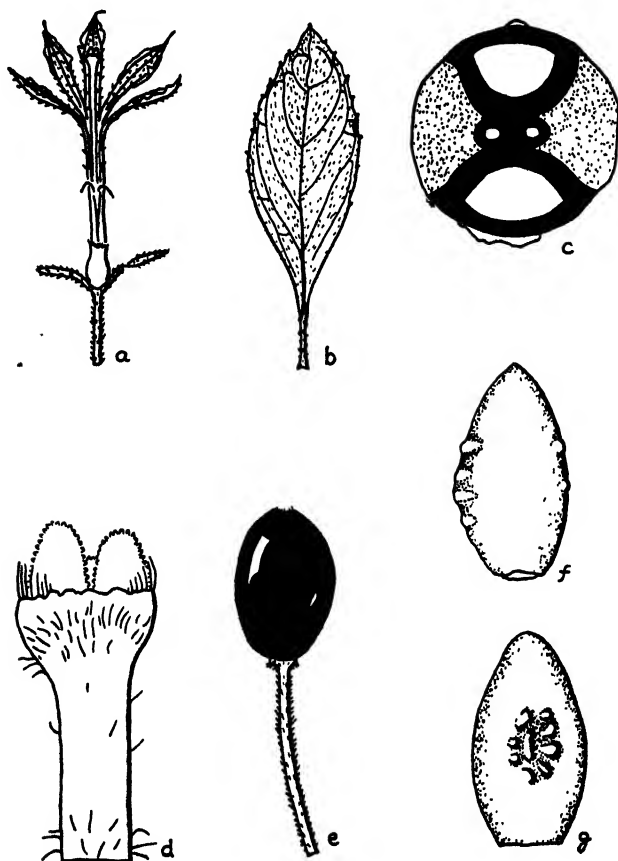


FIGURE 1. *Scaevola Skottsbergii*, new species: a, flower, bracts, and pedicel, $\times 1$; b, leaf, $\times 1/2$; c, cross section of stone showing in black the stony endocarp surrounding the two large fertile locules and the two small sterile lacunae, in the dotted area the spongy mesocarp, in outline the two dorsal rugose projections, $\times 10$; d, tip of style and stigmatic lobes, $\times 10$; e, drupe and pedicel, $\times 2$; f, stone, lateral view, $\times 5$; g, stone, dorsal view, $\times 5$.

corolla whitish with dull lavender veins, pilosulous above the middle, not gibbous.

Though none of the Hawaiian species of *Scaevola* seem to be very close relatives, it is nevertheless desirable to single out the one that is closest and to give the contrasting characters that separate it from the species here described. *Scaevola cerasifolia* Skottsberg,⁴ which is apparently in the section *Sarcocarpaea* like the remaining Hawaiian species, has the leaves acuminate, the blades 7.5-10 cm. long, the margin glandular denticulate with 10-16, usually 12-13, minute teeth; the flowers in axillary 5-9-flowered cymes; the ovary sparsely pilose; the anthers 1.5-2 mm. long; the drupe 8 mm. long, 4 mm. in diameter; the stone laterally compressed, and the stony inner endocarp oval in cross section and completely surrounded by the mesocarp. On the other hand, *S. Skottsbergii* St. John has the leaves subacute apiculate, the blades 3-8 cm. long, the margin with 6-12, usually 8-9, prominent, irregular, apiculate serrations; the pedunculate flowers single in the axils; the ovary glabrous; the anthers 4 mm. long; the drupe 10 mm. long, 7-8 mm. in diameter; the stone scarcely compressed and the stony inner endocarp in cross section seen as two large flattened ellipses, both touching the margin and surrounding the locules, separated by a smaller ellipse around the small rounded sterile lacunae.

Dr. Carl Johan Fredrik Skottsberg, Director of the Göteborg Botanical Garden, is an active student of and an authority on the Hawaiian flora. He has published critical revisions of numerous difficult groups, including the most recent one of our species of *Scaevola*. The new species here named is respectfully dedicated to him.

FAMILY COMPOSITAE

***Pluchea odorata* (Linnaeus) Cassini.**

Oahu: on recent coral fill, Honolulu, October 23, 1931, Carla H. Mirikitani no. 1. A subshrubby weed introduced from Central America or the West Indies. Its occurrence in the Hawaiian islands seems not to have been previously reported.

⁴ Skottsberg, C., *Artemisia*, *Scaevola*, *Santalum*, and *Vaccinium* of Hawaii: B. P. Bishop Mus., Bull. 43, pp. 36-37, figs. 12, 14, c, e, 1927.

CRYPTOCHIRUS OF THE CENTRAL PACIFIC

By

CHARLES HOWARD EDMONDSON

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CRYPTOCHIRUS OF THE CENTRAL PACIFIC

By CHARLES HOWARD EDMONDSON

The genus *Cryptochirus* was established by Heller (2, p. 366)* in 1861 to accommodate a species of small crab occupying pits in heads of living coral. As the crustacean has no means of boring into the coral skeleton it is obvious that the pit is produced by the growth of the coral about the crab, which when young settles down in a calicle, causes the death of the polyp therein, and remains more or less passive while the limy material is gradually laid down about it by the activity of the surrounding coral polyps.

As the crab grows its movements tend to form the shape of the pit and keep free an opening to the exterior through which food and water are admitted. With the growth of the coral colony the pit gradually increases in depth, and in the course of time the crab is permitted more freedom of movement. The movement, however, is chiefly a fore and aft one, the crab being capable of creeping toward the surface or backing into the bottom of the pit. Since the crab fits the tube snugly there is no possibility of a reversal of position, even if such were desirable.

Semper (4, pp. 221-224) describes the appearance of the tubular cavities, noting that the radial septa of the coral calicle are visible in the bottom of the pit, but that the side walls are coated by a calcareous deposit smoothed and polished by the action of the crab. This observer attributes the oblique course which some of the pits take to the strength of the respiratory current set up by the crab, causing the coral polyps to grow in an oblique direction.

Although the crustacean probably seldom leaves the pit, that it is capable of doing so is seen when the coral colony is subjected to high temperature, fresh water, or other abnormal conditions. In most species recorded only females occupy the deeper well-formed pits. It is probable that the female creeps out of the pit when molting occurs. Directly after this process fertilization may take place.

In all species of the genus where both sexes have been observed, the male is smaller than the female and with one exception does not occupy the pit with the female, but moves about more or less freely

* Numbers in parentheses refer to Literature Cited, page 18.

on the surface of the coral colony or rests in a shallow depression. The carapace of the male is more flattened than that of the female, the anterior portion is less declivitous, and the chelipeds are relatively stouter than in the female.

Certain structural features are correlated with the peculiar mode of life of this crustacean. Especially in the female is the anterior portion of the carapace bent down more or less abruptly. This declivitous region together with the first two pairs of legs serves as an operculum which closes the aperture of the pit when the crab approaches the surface. In the female the chelipeds are relatively small and form no obstruction of passage up or down the tube, and the other legs with their sharp dactyli provide levers for progressive and recessive movements. Because of their exposure the declivitous front region of the carapace and the front legs become a depository for sediment which clings to the spines and hairs of the surface. The mature female of *Cryptochirus* is characterized by a broad pouchlike abdomen which when filled with eggs is greatly inflated. A large percentage of adult females taken from coral pits are found to be ovigerous.

Although the genus has been known for more than 70 years it has generally been neglected by investigators, and few species of *Cryptochirus* have been recognized. The small size of the apertures of the pits and their superficial resemblance to the openings of worm tubes may account, in part at least, for the fact that these forms are frequently overlooked.

The type species *Cryptochirus coralliodytes* Heller was described and rather inadequately figured by its author in 1861. Its type locality is the Red Sea, but it has been reported from the Maldive Islands, the Philippine Islands, and probably from the West Indies, Wake Island (p. 16) and Reunion. In this species the chelipeds of the female are shorter than the first walking legs, and the fourth pair of walking legs is longer than the third. The abdomen of the male is linear in outline.

In 1906 Henderson (3, pp. 211-219) described *Cryptochirus dimorphus* from the Andaman Islands. The species was found in a branched madrepora at a depth of 12 fathoms. The specific name is indicative of the marked sex dimorphism; the male is less than one-fourth the size of the female. Both sexes are reported to inhabit the same pit, the male usually clinging to the female. Structurally

the female of this species differs from that of *Cryptochirus coralliodytes* in that the chelipeds are longer and the first pair of walking legs and in the gradual diminution in the length of the legs from the chelipeds to the fourth walking legs, except that the fourth pair is about the size of the third. In the male the abdomen is triangular in form from the third to the seventh segments.

The form described by Verrill (6, p. 427) in 1908 from Bermuda under the name *Troglocarcinus corallicola* should without doubt be referred to the genus *Cryptochirus*. Verrill recognized the affinity of his new genus and species with *Cryptochirus coralliodytes*, but stated that the latter "has a differently formed carapace, smooth, convex in front, without marginal spines." I cannot reconcile Verrill's statement as quoted with the original description of *Cryptochirus coralliodytes* by Heller (2, p. 371): "Die vorderen Seitenränder sind mit 7-8 spitzen Zähnen bewaffnet, die von vorn nach hinten immer kleiner werden. Die ganze Oberfläche des Cephalothorax ist in beiden Geschlechtern mit rauhen, gleichgrossen Körnern ziemlich gleichmässig besetzt, dazwischen feinfilzig." Verrill's species inhabited semicircular or lunate pits in such corals as *Mussa*, *Maeandra*, and *Dichocoenia*. It was reported to be uncommon at Bermuda, but abundant at Dominica Island at from 3 to 5 fathoms.

In 1925 Edmondson (1, pp. 33-35) described *Cryptochirus crescentus* from Johnston Island, where it was found inhabiting crescent-shaped pits in *Pavona duerdeni* Vaughan. The distinctive features of the female of this species are the broad, depressed carapace and the stout second pair of legs with a deep concavity in the medial surface of the merus into which the cheliped fits when the crab is at rest.

During the Tanager Expedition of 1923 and the Whipporwill Expedition of 1924 opportunity was offered for collecting a large number of specimens of *Cryptochirus* from the Central Pacific area. Most of them were taken from corals at Washington, Palmyra, and Christmas islands, and a few were obtained at Johnston and Wake islands. A critical examination of this material leads me to believe that at least five species are represented, three of which, together with another form so far observed only about the Hawaiian islands, are here described as new.

I am indebted to J. E. Hoffmeister of the Smithsonian Institution for the determination of species of corals from Washington, Palmyra, and Wake islands.

Cryptochirus rugosus, new species (pl. 1; fig. 1).

Type, female, carapace 8 mm. long.

Carapace of type specimen (pl. 1, *B, D*; fig. 1, *a, b*) convex in both directions, anterior one-third bent down; front border concave with a small median tooth, on either side of which is a blunt lobe. Antero-lateral angle of carapace rounded with a deep ocular notch (crevice for eye-stalk) bounded below by a blunt process. Antero-lateral border of carapace armed with a row of sharp teeth of about equal size. Antero-medial area of carapace depressed with shallow, pointed furrows extending backward on either side. Upper surface of carapace rough, covered with strong tubercles, spiniform on the anterior half, becoming smaller and blunter posteriorly. Circular gastric area elevated, covered with tubercles. Postero-lateral of gastric elevation, on either side, is a small elevated lobe (epigastric) covered with 10-12 tubercles. A crescent-shaped depression with concavity directed posteriorly separates gastric and cardiac areas. Long hairs, thicker on the anterior declivitous portion, are interspersed between the tubercles of the carapace. Side walls of carapace granular.

Upper surface of basal segment of antennule concave, armed with three sharp teeth, the middle one the longest; ventral border toothed. (See fig. 1, *c*.) Ischium of outer maxilliped (fig. 1, *d*) granular, its median border straight; distal extremity of lateral border of merus rounded; margins of maxilliped heavily fringed with long hairs.

Chelipeds of type specimen (fig. 1, *e*) equal, slender; fingers slightly shorter than palm, the upper proximal border of which bears a few tubercles; carpus longer than palm, dorsal border armed with spiniform tubercles; merus quadrangular in lateral view, toothed along upper border. Upper margin of cheliped fringed with long hairs. First walking legs (fig. 1, *f*) longer and stouter than chelipeds; dactylus, propodus, and carpus subequal in length; carpus and propodus bearing sharp spinules along upper borders; merus broad and stout, a row of spines on upper and lower borders. Long hairs fringe upper and lower margins of merus and dorsal borders of carpus and propodus.

Second and third walking legs (fig. 1, *g*) subequal, shorter than the first, dorsal borders of propodus, carpus, and merus bearing tubercles, some of which are spiniform. Fourth walking leg (fig. 1, *h*) longer than second or third, segments smooth, scantily fringed with long hairs.

Male of species (pl. 1, *E, F*) with carapace more depressed and smoother than that of female; length of carapace of largest individual observed, 5 mm. Chelipeds larger and stouter than in female. Abdomen linear in outline.

Type locality, Washington Island, Bernice P. Bishop Museum, number 3668.

This species of *Cryptochirus* represents one of the largest and by far the roughest, as to surface of carapace, I have observed. Mature females are readily distinguished from other forms by the circular gastric elevation and the two epigastric areas marked off by deep furrows. The straight median border of the ischium of the outer maxilliped is also a distinctive characteristic.

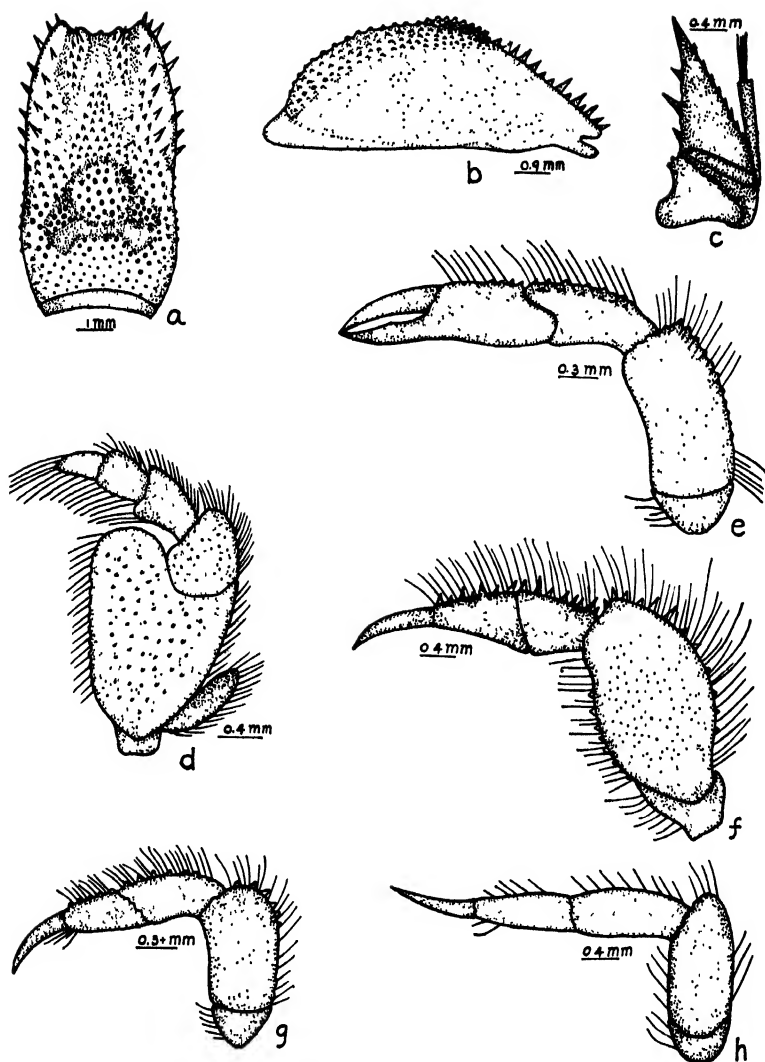


FIGURE 1.—*Cryptochirus rugosus*, new species (female): a, dorsal surface of carapace; b, lateral surface of carapace; c, medial surface of left antennule; d, outer maxilliped, left side; e, left cheliped; f, first walking leg, left side; g, second walking leg, left side; h, fourth walking leg, left side.

Females inhabit tubular pits in *Favia speciosa* (Dana) (pl. 1, A, C). The deepest pit observed was 72 mm. in depth. This remarkable depth of the tube is due to the rapid growth of the coral and its continued growth after the maturity of the crab has been reached. Males were found exposed on the surface of the coral and capable of moving about freely.

***Cryptochirus pacificus*, new species (pl. 2; fig. 2).**

Type, female, carapace 8 mm. long.

Carapace (fig. 2, *a, b*) with posterior two-thirds flattened, anterior deflexed region with a V-shaped depression on either side of the median line; front margin with a small median tooth, on either side of which is a low rounded lobe. Antero-lateral extremity of carapace bluntly rounded; orbital depression deep, bounded below by a toothlike process. Antero-lateral border of carapace armed with a row of sharp teeth of uniform size; upper surface covered with tubercles which are large and spiniform anteriorly, becoming small and blunt posteriorly. A crescent-shaped depression with concavity directed posteriorly separates gastric and cardiac areas. Side walls of carapace granular. Long hairs are interspersed among the tubercles of the surface, the coating being denser on the anterior declivitous region.

Basal segment of antennule (fig. 2, *c*) armed above with three sharp spines, the middle one being the smallest; convex lower border toothed. Outer maxilliped (fig. 2, *d*) with elongate-oval ischium having strongly convex median border; outer distal extremity of merus bluntly rounded; margins of segments fringed with long hairs.

Chelipeds of type specimen (fig. 2, *e*) equal, slender; palm longer than fingers, with a few blunt teeth on dorso-proximal border; carpus as long as palm, distal half of upper border bearing a row of blunt teeth; merus slightly longer than carpus, smooth except for a few blunt teeth on lower margin. Long hairs fringe upper and lower margins of merus and upper borders of carpus and palm.

First walking leg (fig. 2, *f*) longer and stouter than cheliped; propodus and carpus subequal, upper and lateral surfaces bearing sharp spines; merus stout, as long as carpus and propodus combined, upper and lower margins and lateral surface near distal extremity toothed. Long hairs fringe both borders of merus and upper borders of carpus and propodus. Second walking legs (fig. 2, *g*) shorter than the first, armed in a similar manner except there are fewer spines on the ventral border of merus; merus short and stout. Fourth walking leg (fig. 2, *h*) as long as second, slender and unarmed, but scantily fringed with hairs.

Male of species (pl. 2, *E, F*; fig. 2, *i, j*) with carapace 5 mm. long, more depressed than that of female. Cheliped (fig. 2, *i*) stouter and longer than that of female, a few sharp teeth borne on the upper borders of merus, carpus, and manus. Upper border of merus and upper and part of outer surfaces of carpus and manus clothed with hairs. Abdomen (fig. 2, *j*) linear in outline.

Females of this species bear some resemblance to those of *Cryptochirus rugosus* (p. 6), but differ from them in the smoother carapace and in the armature of the appendages. The strong convexity of the median border of the ischium of the outer maxilliped also is a distinctive feature.

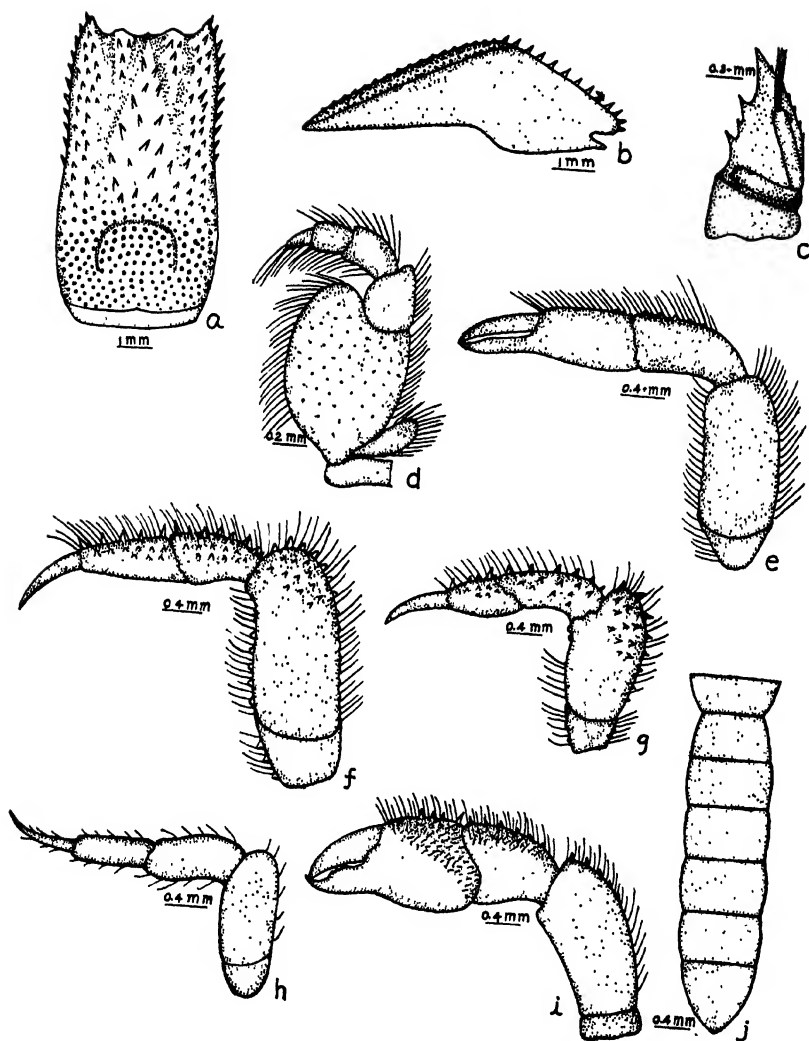


FIGURE 2.—*Cryptochirus pacificus*, new species, a-h, female; i, j, male: a, dorsal surface of carapace; b, lateral surface of carapace; c, medial surface of left antennule; d, outer maxilliped, left side; e, left cheliped; f, first walking leg, left side; g, second walking leg, left side; h, fourth walking leg, left side; i, left cheliped; j, abdomen.

The type specimen (Bernice P. Bishop Museum, number 3669) and female cotypes were taken from a massive coral, *Favia* species (?) (pl. 2, A, C) at Palmyra Island in shallow water. The species was also collected at Washington Island in large blocks of *Maecandra lamellina* Ehrenberg (pl. 2, D). One pit observed had a depth of 32 mm. Males of the species are to be found on the surface of coral heads in the vicinity of the pits occupied by the females.

Cryptochirus pyriformis, new species (pl. 3, A-D; fig. 3).

Type, female, carapace 4 mm. long.

Carapace (fig. 3, a, b) widest in the middle, posterior two-thirds slightly convex in both directions, anterior deflexed area flattened; front margin with a broad median concavity bordered on each side by a rounded lobe. Antero-lateral angle of carapace sharp; orbital fissure broad, bordered below by a sharp tooth. Antero-lateral border of carapace armed by a row of small teeth. Upper surface of carapace uniformly covered with tubercles which are spiniform on the anterior half, but small and granule-like posteriorly. A shallow crescent-shaped groove with concavity directed posteriorly separates gastric and cardiac areas. Side walls of carapace finely granular.

Basal segment of antennule (fig. 3, c) stout; upper border armed with a row of five teeth; convex lower border toothed, three or four teeth at the distal extremity stout and sharp.

Outer maxilliped (fig. 3, d) with median margin of ischium rounded; segments distal to ischium short and stout; lateral border of merus rounded; long hairs fringe the margins of the segments.

Chelipeds of type specimen (fig. 3, e) equal, short and stout; fingers as long as palm, which is about one-half the length of carpus; upper borders of palm and carpus bear a few blunt teeth; merus slightly longer than high, surface and margins unarmed; upper and lower borders of merus and upper borders of carpus and manus fringed with hairs.

First walking leg (fig. 3, f) longer than cheliped, the propodus and carpus subequal in length; merus compressed, its height three-fifths that of its length; dorsal and broadly rounded anterior border of merus and upper borders of carpus and propodus bearing sharp spines. Long hairs fringe dorsal and ventral margins of merus and dorsal borders of carpus and propodus. Second walking leg (fig. 3, h) shorter than first; height of merus two-thirds that of its length; blunt teeth and long hairs are borne on the dorsal borders of propodus, carpus and merus; ventral border of merus fringed with hairs. Fourth walking leg (fig. 3, g) shorter than second; dactylus, propodus, and carpus long and slender; height of merus one-half that of its length; blunt teeth borne on the upper borders of propodus and carpus; hairs fringe upper margins of propodus, carpus, and merus.

Male species with cheliped (fig. 3, i) stouter than that of female; palm as deep as long and subequal in length with that of carpus; height of merus one-half of its length; cheliped smooth, but surface well covered with hairs.

Mature ovigerous females of this species may be recognized by the short, broadly-inflated abdomen, which conforms to the shape of the cavity in which

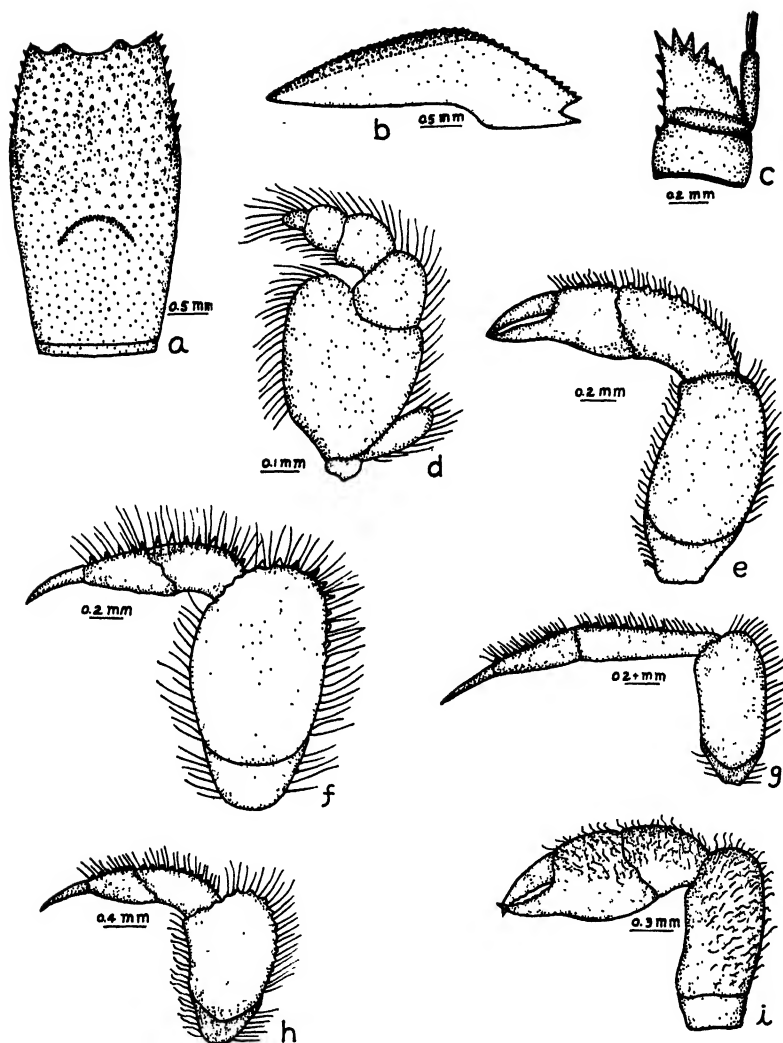


FIGURE 3.—*Cryptochirus pyriformis*, new species, *a-h*, female, *i*, male: *a*, dorsal surface of carapace; *b*, lateral surface of carapace; *c*, medial surface of antennule; *d*, outer maxilliped, left side; *e*, left cheliped; *f*, first walking leg, left side; *h*, second walking leg, left side; *g*, fourth walking leg, left side; *i*, left cheliped.

the animal is concealed. The chelipeds are relatively stouter than in *Cryptochirus rugosus* (p. 6) or *Cryptochirus pacificus* (p. 8) and the height of the merus compared with its length is greater than in those species. The blunt teeth borne on the fourth walking legs also separate this species from others observed.

Type locality, Washington Island, Bernice P. Bishop Museum, number 3670.

Females commonly inhabit shallow pits, about 8 mm. deep, in the coral, *Favites abdita* (Ellis and Solander) (pl. 3, *A, B*) and have been observed in *Orbicella curta* Dana and *Hydonophora* species. The cavity increases in diameter below the narrow aperture and this shape probably prevents the ovigerous female from leaving her place of concealment. Males are much smaller than females and do not occupy pits, but move about freely on the surface of the coral heads.

***Cryptochirus minutus*, new species (pl. 3, *E, F*; fig. 4).**

Type, female, carapace 3 mm. long.

Carapace (fig. 4, *a, b*) quadrangular when viewed from above; posterior three-fourths flat, short anterior region bent abruptly downward; serrated front margin with a broad median concavity bordered on either side by an acute process which extends beyond the sharp antero-lateral angle of the carapace. Ocular depression broad and deep, bordered below by a sharp, toothlike process.

Antero-lateral border of carapace armed with 6 short teeth; declivitous area granular and bearing numerous sharp spines; two broad oval depressions mark this region, which is densely coated with hairs. Posterior, flattened area of carapace covered with granules and small tubercles, some of which are spiniform; side walls of carapace finely granular.

Basal segment of antennule (fig. 4, *c*) armed above by a few strong teeth and below by smaller ones. Ischium of outer maxilliped (fig. 4, *d*) almost as broad as long, surface smooth; lateral border of merus serrated, its distal extremity acute.

Cheliped of type specimen (fig. 4, *e*) equal, stout; dactylus as long as upper border of manus, which is equal to the greatest depth of hand; carpus as long as palm and shorter than merus. Upper borders of manus, carpus, and of merus, in part, bearing strong spines and densely coated with hairs.

First walking leg (fig. 4, *f*) equal in length to cheliped; propodus and carpus subequal, their combined length equal to that of merus; strong spines and a thick coating of hairs borne on upper borders of merus, carpus, and propodus. Second walking leg (fig. 4, *g*) shorter than first; carpus longer than propodus and subequal in length with merus. Short blunt teeth and serrations arm the upper borders of merus, carpus, and propodus. Fourth walking leg (fig. 4, *h*) slender, unarmed, as long as cheliped.

Chelipeds of male (fig. 4, *i*) shorter and stouter than those of female; palm inflated; as deep as long; dorsal borders of manus, carpus, and merus bearing

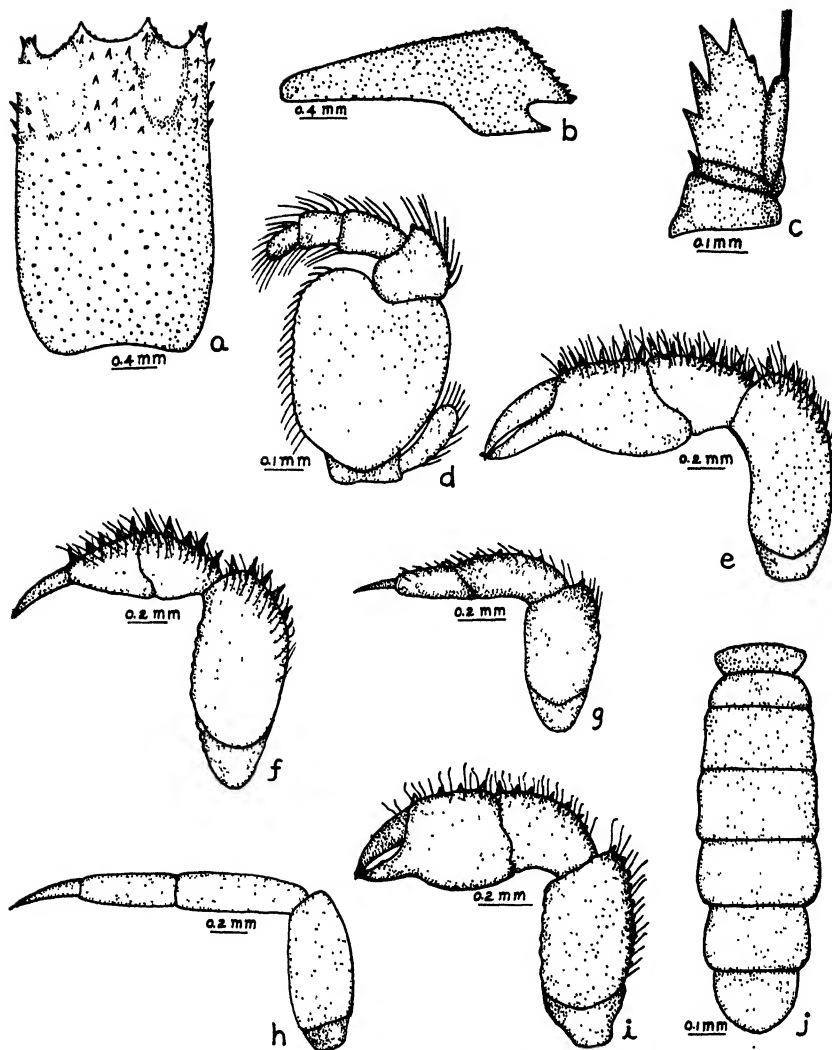


FIGURE 4.—*Cryptochirus minutus*, new species, a-h, female; i, j, male: a, dorsal surface of carapace; b, lateral surface of carapace; c, medial surface of left antennule; d, outer maxilliped, left side; e, left cheliped; f, first walking leg, left side; g, second walking leg, left side; h, fourth walking leg, left side; i, left cheliped; j, abdomen.

teeth and a fringe of hairs. Abdomen of male (fig. 4, j) linear in outline with sinuose borders; fifth segment broadest, sixth and seventh successively narrower.

Zoea of species (fig. 6, a, c) with carapace armed with frontal, dorsal, and lateral spines, the dorsal being long; telson of abdomen narrow, elongated, posterior margin with a long stout spine at each lateral border and six median spinelets; a slender spinelet is borne at the lateral base of each strong spine.

This species is one of the smaller representatives of the genus and may be distinguished by the short declivitous region of the carapace marked by two broad oval depressions, and a serrated front margin. The stout chelipeds and strong teeth of the basal segment of the antennule also are features by which the species may be recognized.

Type locality, Waikiki Reef, Oahu, Bernice P. Bishop Museum, number 3671.

Females of the species inhabit pits in *Cyphastrea ocellina* and *Leptastrea purpurea*, being more abundant in the former than in the latter coral. Especially is *Cyphastrea ocellina* heavily infested by this crab on Waikiki Reef and in Hanauma Bay, Oahu. It is less plentiful in the same species of coral on the shoal reefs of Kaneohe Bay, Oahu.

Some of the pits concealing females reach a depth of 12 mm. and many are curved or angular in their course. Males, which are about 1.5 mm. long, do not inhabit pits with females, but are found on the surface of the coral in shallow depressions or in a calicle in which the coral polyp has been destroyed.

Cryptochirus coralliodytes Heller (?) (pl. 4, A, B; fig. 5).

Cryptochirus coralliodytes Heller, Sitz. Ber. Akad. Wissen. Wien. vol. 43 (1), pp. 370, 371, pl. 4, figs. 33-39, 1861; Edmondson, Bernice P. Bishop Museum, Bull. 27, p. 32, pl. 1, 1925.

Carapace (fig. 5, a, b) subquadrangular in dorsal view, 5 mm. long, widest posterior to the middle, convex in both directions; front margin with a median rounded lobe, the shallow depression on each side bordered by a blunt process which is not so extended as the antero-lateral angle of the carapace. Orbital notch shallow, followed by a shallow groove in the side wall of the carapace and bounded below by a sharp tooth.

Anterior flexed area of carapace narrowly depressed on each side of the mid line; antero-lateral border armed with a row of teeth gradually decreasing in size from the front backward; spiniform tubercles interspersed with long hairs cover the anterior half of carapace; posterior half covered with blunt tubercles and granules. A shallow crescent-shaped groove separates gastric and cardiac areas.

Dorsal border of basal segment of antennule (fig. 5, c) with a row of teeth, the stronger ones at the distal extremity; lower border serrate.

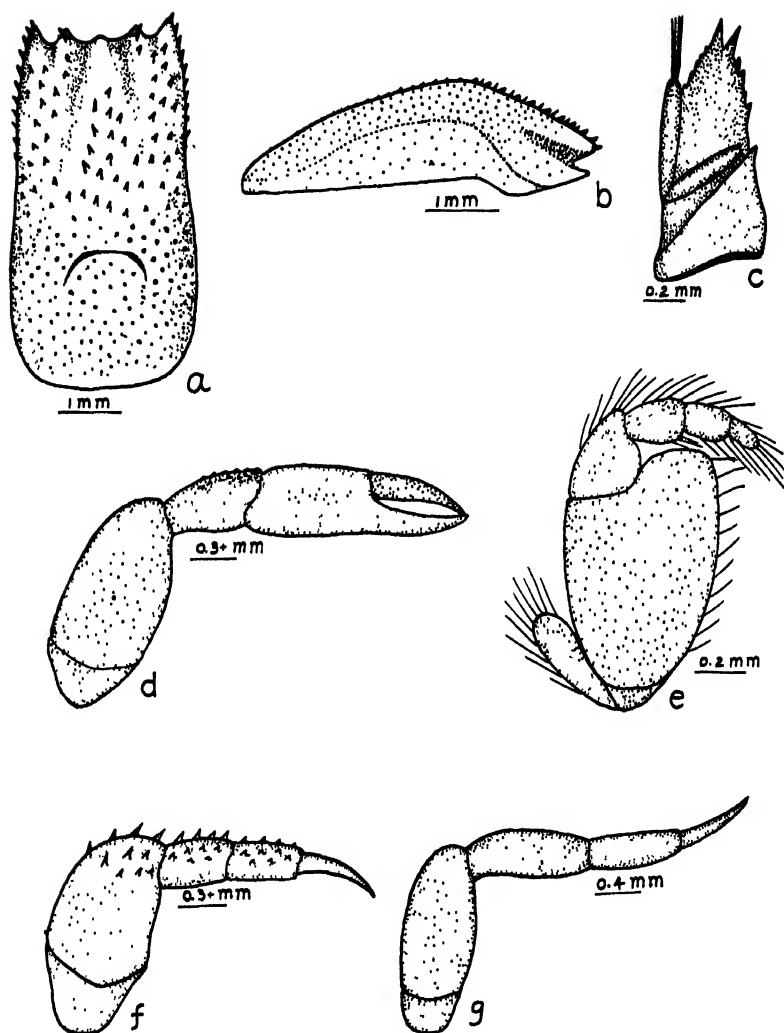


FIGURE 5.—*Cryptochirus coralliodytes* Heller (?), female, from Wake Island: *a*, dorsal surface of carapace; *b*, lateral surface of carapace; *c*, medial surface of right antennule; *d*, right cheliped; *e*, outer maxilliped, right side; *f*, second walking leg, right side; *g*, fourth walking leg, right side.

Chelipeds of female (fig. 5, *d*) equal, slender, dactylus as long as upper border of manus; palm and fingers unarmed; carpus smooth except for some blunt tubercles on dorsal border; merus smooth, its length less than twice its depth.

Ischium of outer maxilliped (fig. 5, *e*), longer than broad, inner margin smooth and rounded; merus smooth, its latero-distal border rounded, but not projected. (In the type specimen this border is projected and pointed.) Second walking leg (fig. 5, *f*) shorter than cheliped; merus short and deep; propodus, carpus and merus, in part, armed with sharp spines. Fourth walking leg (fig. 5, *g*) longer than cheliped, its surface smooth. Abdomen of female long and narrow, greatly extended beyond the carapace.

A specimen collected at Wake Island by the Tanager Expedition is reported by Edmondson (1, p. 32) to conform closely with Heller's description of *Cryptochirus coralliodytes*. Although it is still tentatively considered a representative of Heller's species, further study of this specimen has revealed some apparent differences, the certainty of which may be determined only by a comparison with type material. The specimen occupied a pit in a colony of *Favia pallida* (Dana). (See pl. 4, *A*.)

***Cryptochirus crescentus* Edmondson (pl. 4, *C, D*).**

Cryptochirus crescentus Edmondson, B. P. Bishop Mus., Bull. 27, pp. 33-35, pl. 1, fig. 6, 1925.

In addition to the type locality, Johnston Island, the distribution of this species is now known to include Christmas Island (North Pacific Ocean), where it was found by the Whipporwill Expedition to be abundant, occupying crescent-shaped pits in *Pavona duerdeni*. Indications of its presence in the Hawaiian islands are seen in unoccupied crescent-shaped pits in bleached specimens of *Pavona duerdeni* from Pukoo, Molokai, now in Bernice P. Bishop Museum. Samples of this coral collected at Waikiki and Hanauma Bay, Oahu, are not infested by the crab. It is quite likely, however, that the crustacean may be found throughout the distributional area of *Pavona duerdeni*. Careful examination of other species of *Pavona* also might reveal its presence.

There has been some discussion relative to the affinity of species of *Cryptochirus* and another coral-infesting crab, *Hapalocarcinus marsupialis* Stimpson (5, pp. 412-413), which inhabits galls on many species of corals, of which *Pocillopora cespitosa* is the prevailing one in Hawaii.

Of the species of *Cryptochirus* observed I have had opportunity of studying the larvae of but one, *Cryptochirus minutus* (p. 14). On comparing the zoea of this species with that of *Hapalocarcinus marsupialis* (fig. 6, b, d) the close resemblance is obvious. The similarity is seen to exist in the spinous processes of the carapace and also in the abdomen of the two species. Chief differences seem to be in the lateral processes of the fifth segments of the abdomen, and

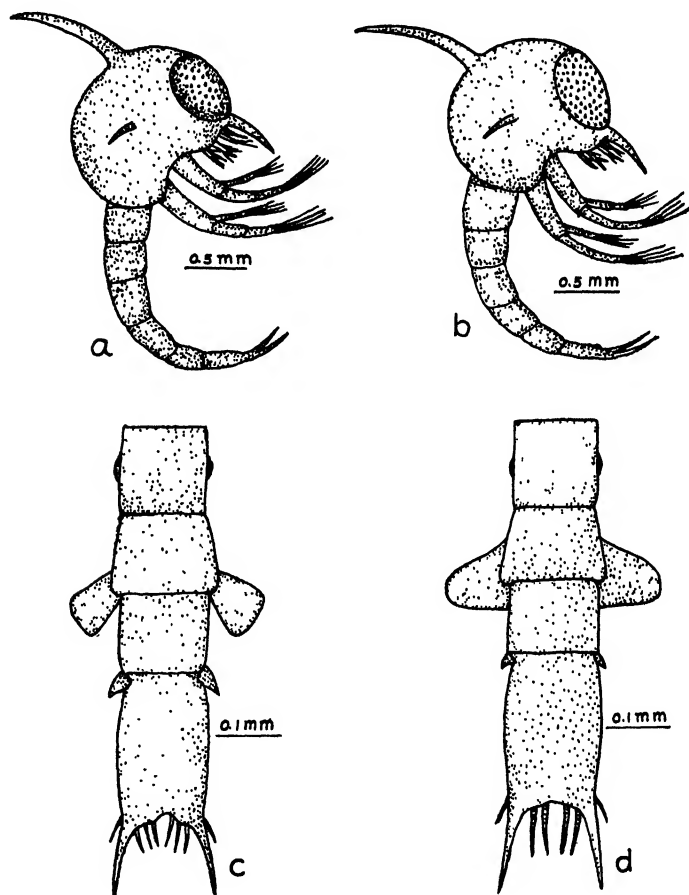


FIGURE 6.—Zoea of *Cryptochirus minutus* (a) and of *Hapalocarcinus marsupialis* (b); last four segments of abdomen of zoea of *Cryptochirus minutus* (c) and of *Hapalocarcinus marsupialis* (d).

in the spinules of the posterior margin of the telson, which in *Hapalocarcinus marsupialis* are longer but fewer than in *Cryptochirus minutus*.

Most authorities have based their belief in the close relationship of the two genera of coral-infesting crustaceans, *Hapalocarcinus* and *Cryptochirus*, on the structural resemblance of the adults. The larval resemblance is now seen to support this belief.

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PLATE LEGENDS

PLATE 1. *CRYPTOCHIRUS RUGOSUS*, NEW SPECIES.

A. Surface of coral, *Favia* species (?) from Washington Island, showing aperture of pit inhabited by female crab. *B.* Dorsal surface of female, $\times 5.5$. *C.* Section of coral, *Favia* species (?) showing outline of pit 60 mm. deep. *D.* Dorsal surface of female, $\times 6$. *E, F.* Dorsal and ventral surface, respectively, of male, $\times 6$.

PLATE 2. *CRYPTOCHIRUS PACIFICUS*, NEW SPECIES.

A. Surface of coral, *Favia* species (?) from Palmyra Island, showing aperture of pit inhabited by female crab. *B.* Dorsal surface of female $\times 5$. *C.* Section of coral, *Favia* species (?) showing outline of pit. *D.* Surface of coral, *Maeandra* species from Washington Island, showing aperture of pit inhabited by female crab. *E, F.* Dorsal and ventral surfaces, respectively, of male, $\times 8$.

PLATE 3. *CRYPTOCHIRUS PYRIFORMIS* AND *CRYPTOCHIRUS MINUTUS*, NEW SPECIES.

A. Surface of coral, *Favites abdita* from Washington Island, showing aperture of pit inhabited by *Cryptochirus pyriformis*. *B.* Section of *Favites abdita* showing outline of pit 8 mm. deep inhabited by *Cryptochirus pyriformis*. *C, D.* Dorsal and ventral surfaces, respectively, of female *Cryptochirus pyriformis*, $\times 7$. *E.* Surface of coral, *Cyphastrea ocellina* from Oahu, showing female *Cryptochirus minutus* in aperture of pit. *F.* Dorsal surface of female *Cryptochirus minutus*, $\times 10$.

PLATE 4. *CRYPTOCHIRUS CORALLIODYTES* HELLER (?) AND *CRYPTOCHIRUS CRESCENTUS* EDMONDSON.

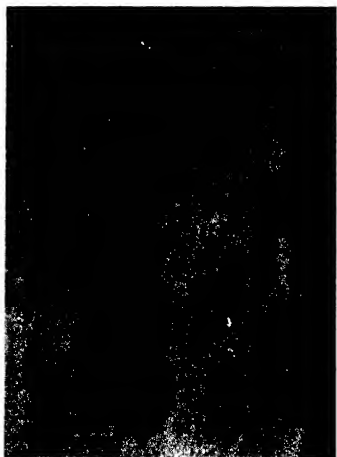
A. Surface of coral from Wake Island showing aperture of pit inhabited by *Cryptochirus coralliodytes* (?). *B.* Dorsal surface of *Cryptochirus coralliodytes* (?) from Wake Island. *C.* Pit in coral, *Pavona duerdeni* from Christmas Island, North Pacific Ocean, inhabited by *Cryptochirus crescentus*. *D.* Dorsal surface of *Cryptochirus crescentus* from Christmas Island, $\times 12$.



A



B



C



D



E



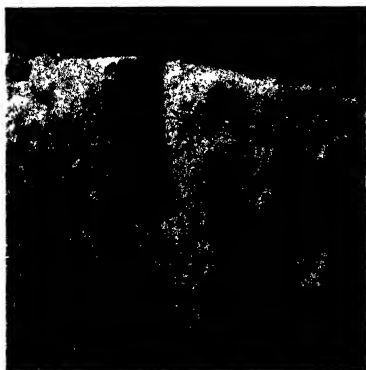
F



A



B



C



D



E



F

PLATE 2.—*CRYPTOCHIRUS PACIFICUS*, NEW SPECIES.

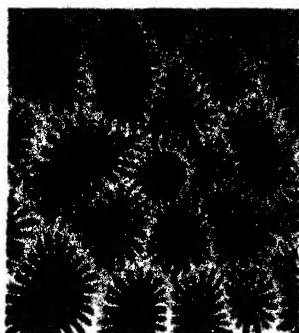
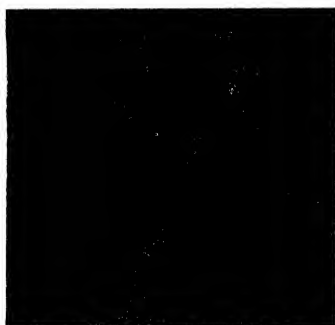
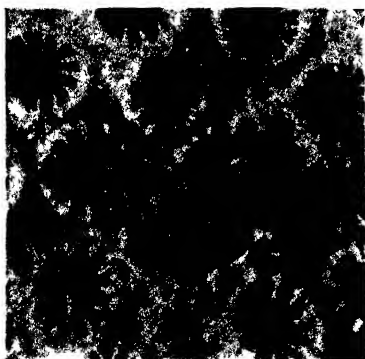
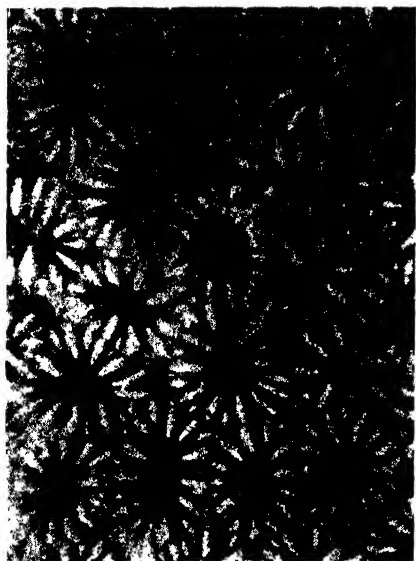
*A**B**C**D**E**F*

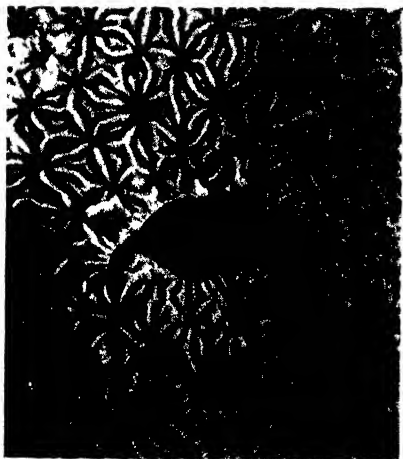
PLATE 3.—*CRYPTOCHIRUS* PYRIFORMIS AND *CRYPTOCHIRUS* MINUTUS,
NEW SPECIES.



A



B



C



D

PLATE 4.—*CRYPTOCHIRUS CORALLIODYTES* HELLER (?) AND
CRYPTOCHIRUS CRESCENTUS EDMONDSON.

NEW SPECIES OF AMASTRIDAE

By

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NEW SPECIES OF AMASTRIDAE

By C. MONTAGUE COOKE, JR.

Most of the material on which this paper is based has been added to the Bernice P. Bishop Museum collection since the publication of my paper dealing with a few new species of *Amastra* in 1917.¹

The genus *Amastra* is still open for much further study, as the field is by no means fully explored, especially on the islands of Maui and Hawaii. From what is known of species that have already been collected and of their distribution, much new material should be found on east Maui, especially representatives belonging to *Heteramastra*. The Kohala and Waimea districts on Hawaii should prove to be rather rich in isolated species or subspecies.

Kauai and Molokai should undoubtedly yield a number of new forms. Oswald's collecting on Oahu during the last three years has added a number of hitherto unknown species and subspecies or geographical races. From his collecting, it would seem that with more intensive work on Oahu many new types could be added. There is no doubt that the Pleistocene deposits will be a continual source of many new and very distinct types of this most interesting genus.

The color terms used in the descriptions of the living species are taken from Ridgway's "Color Standards and Nomenclature" (1912).

My thanks are due to the many friends of the Museum who are continually adding new material to the collection.

Genus PLANAMAstra

Planamastra spaldingi, new species (pl. 2, figs. 1, 2).

The shell is broadly umbilicate, subdiscoidal, very thin, dull, of a uniform tawny-olive color. The spire is very slightly elevated, so that all the whorls are visible when the shell is viewed from the front. The embryonic whorls are somewhat convex, the post-embryonic are strongly convex, separated by a deep, simple suture, finely, irregularly and closely striate, with a distinct narrow sulcus just above and accompanying the suture; last whorl flattened above, bluntly angular at the periphery. The periphery, except for its last one-sixth, is accompanied both above and below by distinct, narrowed sulci. Aperture nearly quadrilateral, with rounded corners, its outer margin thin. Umbilicus large, perspective, a little more than one-third the total diameter, its outer margin not distinctly angular. Height, 2.7 mm.; diameter, 6.2 mm.; whorls, 4.

¹ Cooke, C. M., Jr., Some new species of *Amastra*: B. P. Bishop Mus. Occ. Papers, vol. 3, no. 3, 1917.

Oahu, Waianae Mountains: Pukaloa (I. Spalding, W. Meinecke, C. M. Cooke Jr.; Haleanau [Haleauau] (D. Thaanum, W. Wilder); Lualualei (O. Oswald). Type no. 10755.

Planamastra spaldingi should be considered a very rare species. In the Museum collection are eight lots; five are from the small valley of Pukaloa. In only one of the lots are there more than two specimens, and not more than 25 to 30 shells have come to my notice.

The first specimens of *P. spaldingi* which were recognized as distinct from *P. digonophora* were collected by Spalding, and one of these, a recently dead shell, is selected for the type. The first and only live shell of the species which I have examined was given by Oswald to the Museum from his collection made in 1928 in the valley of Lualualei, where one live and two or three dead specimens were taken.

During 1926 Meinecke collected a small series of recently dead juveniles from Pukaloa, but found no adults. Oswald's specimen is somewhat darker in color than the type, being of a uniform russet. The shell has a few small, scattered, agglutinated deposits near and on the periphery. Like the deposits on living examples of *P. digonophora* these are not alate, as is common in the species of *Pterodiscus*. A juvenile collected by Meinecke has somewhat stronger deposits. In another juvenile with slightly more than two and one-half whorls, there is not the slightest indication of a columellar fold.

P. spaldingi is easily distinguished from *P. digonophora* by its higher spire (in *P. digonophora* the spire is flat or immersed), its more convex embryonic whorls, and its proportionately narrower umbilicus, the outer margin of which is not as sharply angled. Another distinctive characteristic is that the inner walls of whorls forming the umbilicus are convex, whereas the corresponding walls of *P. digonophora* are flattened.

***Planamastra spaldingi koolauensis*, new subspecies (pl. 2, figs. 3, 4).**

Above the periphery this subspecies is nearly similar in its characters to typical *P. spaldingi*. Its most important differences are found below the periphery. The umbilicus of this subspecies is proportionately much smaller, being slightly more than one-fourth the total diameter of the shell, its outer margin rounded and with the last whorl uniformly convex when viewed from below. Height, 3.0 mm.; diameter, 6.3 mm.; whorls, 4.

Oahu: Pleistocene or later deposit, Kahuku, in deposit on limestone bluff above pumping station 1.2 miles northeast of Kahuku Mill (C. M. Cooke Jr.); Punaluu, in Pleistocene deposit on flat at foot of northern ridge of valley in ploughed field (C. M. Cooke Jr.). Type, no. 10754; paratypes, no. 60079.

It is remarkable that neither in the very rich fossil deposits nor among the large series of contemporary material has a single specimen of *Planamastra* ever been recorded from the region between Kahuku and the Waianae Mountains. It probably inhabited the sides of the bluffs and the coastal plains when these were wooded. Either living or recently dead specimens would certainly have been recorded long before this if the genus had ever been an inhabitant of the damper rain forests.

A juvenile with slightly more than two and one-half whorls has no indication of a columellar fold.

The type lot from Kahuku consists of one whole adult, one badly broken, and two very young shells. The lot from Punaluu contains nine shells, none of which have as many as four whorls.

Genus AMASTRA

Subgenus CYCLAMASTRA

Series of *Amastra sphaerica*

1. *Amastra (Cyclamastra) cyclostoma gregoryi*, new subspecies, (pl. 1, fig. 1).

The shell is narrowly umbilicate, conically heliciform, solid, strongly carinate at the periphery, in its fossil state white below, shading gradually to apricot orange on the embryonic whorls. Spire broadly conic, with slightly concave outlines. The embryonic whorls are nearly smooth, slightly convex. The last two whorls have weak, irregular growth-lines. The last whorl is swollen, strongly carinate at the periphery, flattened above, convex below the carina, and shouldered just below the suture, its last third descending. The carina, beginning almost at the inception of the penultimate whorl, is strong and distinctly margined above and below with deeply incised sulci, extending to, but becoming less defined, on approaching the margin of the aperture, which is but slightly modified. The aperture is irregularly circular. Peristome slightly thickened within, indistinctly duplicate without. Columella oblique, narrowly triangular, furnished near its middle with a low, rounded fold which scarcely reaches the outer margin. Umbilicus nearly circular, about one-ninth of the diameter, with rounded margin. Length, 20.6 mm.; diameter, 24.4 mm.; aperture diagonal, 12.2 mm.; whorls, 6. Type, no. 100492.

Kauai: limestone bluff about 0.5 mile east of Aweoweonui Bay, in Mahaulepu, 50 to 75 feet above sea level (C. M. Cooke Jr.).

One whole adult and fragments of three additional specimens of this subspecies have been examined. From the fragments, it is evident that shells may be found which are somewhat wider than the type.

The most important difference between the species *Amastra cyclostoma* and the form here considered a subspecies is one of size, as the dimensions of the subspecies are about 40 to 50 per cent larger than those of the species. In *A. c. gregoryi* the peripheral carina is much more pronounced than in most specimens of *A. cyclostoma*, and it extends to and modifies, to a slight degree, the outer margin of the aperture.

The habitats of the two forms are separated by a little more than 13 miles. The original specimens of *A. cyclostoma* were taken by A. F. Judd at Makaweli. Since then, the only additional material of which I have any knowledge was found by Mr. Perkins at "Makaweli, 2,000 feet elevation." *A. c. gregoryi* was taken near sea level in a Pleistocene limestone deposit. No specimen of a related form of *Amastra* has been reported from an intermediate locality.

A. c. gregoryi has the distinction of being by far the largest form belonging to the subgenus *Cyclamastra*, and it has a greater diameter than any species or subspecies of the genus *Amastra*.

Series of *Amastra umbilicata*

2. *Amastra (Cyclamastra) juddii* Cooke.

When this species was published,² the habitat of the three specimens collected by Mr. Judd was not known. Typical examples of this species have been taken by W. Meinecke (1926) and T. Dranga (1926). Both lots came from the same locality in Olokele Canyon "just above the bend in the trail above Rainbow Falls." Undoubtedly Mr. Judd's specimens are from a locality in or near the drainage basin of Waipea Canyon. In 1903 a single dead specimen of *A. juddii* was collected by me along the trail in Olokele. By some mischance, the specimen was overlooked when I was preparing the paper in 1917.

² B. P. Bishop Mus. Occ. Papers, vol. 3, no. 3, p. 5, 1917.

3. *Amastra (Cyclamastra) delicata*, new species (pl. 1, fig. 2).

The shell is narrowly but openly umbilicate, conic, very thin, translucent, scarcely shining, russet to Mars brown, shading to a lighter color near the umbilicus and in back of the peristome. The spire is conic, whorls uniformly convex. Embryonic whorls flatly convex, glossy, nearly smooth, under a very strong lens very finely striate; the post-embryonic whorls convex, separated by a simple suture, the surface distinctly marked by fine, slightly flexuous distinct growth-wrinkles, which are more or less unevenly spaced and become coarser and more widely spaced with the growth of the shell. Aperture broadly ovate, subcircular, its outer margin sharp, dark-edged, and furnished with a low, indistinct lip-rib. Columellar lamella distinct, high and thin, not reaching the outer margin of the columella. Umbilicus rather narrow, nearly semicircular in section.

Length	Diameter	Aperture Diagonal	Whorls
10.4 mm.	6.7 mm.	4.6 mm.	6½ (Cotype, pl. 1, fig. 2)
9.5 mm.	6.1 mm.	4.3 mm.	6¼ (Cotype)

Kauai: Nonou Mountains in high valley just west of peak, 700-900 feet elevation (D. Thaanum, 1919, T. and J. Dranga and C. M. Cooke Jr., 1925), type locality; Hii Mountains, foot of Kalihi Peak (C. N. Forbes, 1916). Cotypes, no. 10770; paratypes, nos. 80942-45; topotypes, in Thaanum collection.

Adult specimens are sparsely, immature specimens thickly, agglutinated. The shells collected by Forbes are very slightly larger than those from the type locality about 11 miles away. One of them measures: length, 10.7 mm.; diameter, 6.5 mm. The two lots agree in all essential characters.

A. delicata appears to be related to *A. rugulosa* Pease, but it differs in its thinner shell, larger umbilicus, and less pronounced striations. From these characters I have considered it as belonging to the subgenus *Cyclamastra*. Two of Pease's specimens of *rugulosa* in the Museum collection have the shells minutely perforate and the outlines of the spire more convex.

A. delicata is much nearer in size to *A. rugulosa normalis*, but differs in its very much thinner shell, more irregular sculpturing, color pattern, and relative size of the umbilicus.

4. *Amastra (Cyclamastra) globosa*, new species (pl. 1, fig. 3).

The shell is narrowly umbilicate, globose, glossy, in its fossil state the last two whorls are white, the two upper Sanford's brown, the two intermediate whorls shading to white with the growth of the shell. The spire is very short,

slightly less than the length of the aperture, broadly conic, with nearly straight outlines, not contracted toward the summit. The embryonic whorls are convex, nearly smooth even under a strong lens; the rest of the whorls are distinctly convex, separated by a deep suture, finely and irregularly striate with rather sharp growth-wrinkles. The aperture is slightly more than half the length of the shell, its outer margin regularly curved, furnished with a thick, heavy lip-rib. The columella is narrowly triangular, truncate near its base, with a blunt, low, columellar fold. There is a short low tooth on the parietal wall. The umbilicus is rounded. Length, 18.4 mm.; diameter, 12.7 mm.; aperture diagonal, 9.8 mm.; whorls, 6.

Oahu: Kahuku, in limestone bank above the sand beach, slightly northeast of wireless station (C. M. Cooke Jr., 1930). Type, no. 98238.

Unfortunately, but a single specimen of this species has been taken. It is undoubtedly descended from the same stock as *Amastra antiqua*, *A. antiqua kawaihapaiensis*, and *A. elephantina*. From these it differs principally in its more globose form and decidedly more convex whorls, especially the embryonic. The degree of sculpturing of the surface is about midway between *A. antiqua* and *A. a. kawaihapaiensis*. From *A. elephantina* it also differs in its more regular and more widely spaced, though fine, growth-wrinkles.

These four forms compose a rather compact group. They are characterized by their rather large size and, in old specimens, are furnished on the parietal wall with a well-defined tooth, or at least with a thickened swelling. The few specimens which have been taken would indicate that this group was widely dispersed over most of the lowlands of Oahu.

Since the publication of volume 23 of Pilsbry's Manual of Conchology (1915-1916) a number of what are apparently typical specimens of *A. antiqua*, all fossil, have been taken in the northwestern side of Manoa Valley in road cuttings and house sites from the beginning of Oahu Avenue to just below Awapuhi Street. A few specimens have also been taken from the southerly slope of Rocky Hill.

5. *Amastra* (*Cyclamastra*) *thurstoni bembicodes*,³ new subspecies
(pl. 1, fig. 4).

The shell is openly perforate, acuminate conic, and, in its fossil state, white. The outlines of the spire are concave, slightly contracted below the embryonic whorls, which are wide, slightly convex, faintly and regularly

³ βεμβικωδης = like a top.

striate. The post-embryonic whorls are flatly convex, nearly smooth, with faint widely spaced irregular growth-wrinkles. The aperture is ovate, its outer margin regularly curved and furnished with a delicate lip-rib. The columella is narrowly triangular, its inner margin straight and furnished with a strong, subhorizontal fold which extends to the outer margin of the columella. The perforation is narrow, subcircular, compressed on one side by the free margin of the columella.

Length	Diameter	Aperture	Whorls
		Diagonal	
11.3 mm.	6.1 mm.	5.0 mm.	6¼ (Cotype, pl. 1, fig. 4)
10.1 mm.	5.3 mm.	4.3 mm.	6¼ (Cotype)

Oahu: Manoa, fossil in road cuttings near the corner of Ferdinand Street and Adolphe Street, type locality (F. Girdler, C. M. Cooke, III, and C. M. Cooke, Jr., 1916), Round Top Road above Awapuhi Street (C. M. Cooke, Jr., 1915). Cotypes, no. 43100.

This is an exceedingly rare form of *Amastra*. The results of five findings are six whole and three broken specimens. Among the large number of *Amastras* that have been taken in the Manoa fossil deposits, from the beginning of Oahu Avenue to Awapuhi Street, this form was only taken from four "pockets."

From *A. thurstoni* it differs in its smaller size, compact and closely coiled spire, but especially in its smoother surface marked with finer and more distantly spaced growth-wrinkles.

The fine and regular striation of the embryonic whorls is similar in both the typical and subspecific forms, a character which decisively links them together; otherwise, it would not be inappropriate to consider them as distinct species. The umbilicus of *A. t. bembicodes* is proportionately slightly wider than that of *A. fragilis* from Molokai, and *A. metamorpha* and *A. m. debilis* from west Maui.

6. *Amastra (Cyclamastra) problematica*, new species (pl. 1, fig. 5).

The shell is minutely perforate, oblong-turrite, and, in its fossil state, white. Spire acuminate conic, with nearly straight outlines. The embryonic whorls are indistinctly striate, convex; the post-embryonic are marked with very fine, closely set, oblique growth-wrinkles. The upper post-embryonic whorls are distinctly convex, the penultimate and last slightly flatter; the last whorl is rather narrow, subcylindrical, tapering gradually to the base. The suture is simple and distinct. The aperture is ovate, rather broad in proportion to its length, its outer margin regularly curved and furnished with a strong lip-rib. The inner margin of the columella is straight, the outer margin slightly thickened and arched over the very narrow cleftlike umbilicus; columella furnished at its lower third with a strong columellar fold.

Length	Diameter	Aperture	
		Diagonal	Whorls
11.2 mm.	5.2 mm.	4.8 mm.	6 $\frac{1}{8}$ (Cotypes)
11.8 mm.	5.4 mm.	4.8 mm.	6 $\frac{1}{2}$ (Cotypes, pl. 1, fig. 5)
9.5 mm.	4.9 mm.	4.3 mm.	5 $\frac{3}{4}$ (Cotypes)

Oahu: Kawailoa, 0.3 mile northeast of railway station in shallow railroad cutting, also in road bank 0.9 mile northeast of same railway station; Malaekahana just inland of government road 0.6 mile northwest of Laie bridge; Kahuku Point near wireless station; Waialei railroad cutting; Waimea, road cutting (C. M. Cooke, Jr., 1917). Type, no. 10772; paratypes, no. 44928.

The position of this species is at first glance rather doubtful, as the perforation is proportionately much smaller than in any other species belonging to the subgenus *Cyclamastra*. From the convexity and type of coiling of the embryonic and post-embryonic whorls up to and through the metaneanic stage, this species is closely related to *Amastra umbilicata*. In the characters of the adult whorl, *A. problematica* differs considerably from *A. umbilicata*. The shells of *A. umbilicata* are much broader in proportion to their length. The last whorl is slightly more convex and tapers more abruptly toward the base, and the umbilicus is more open. The aperture of *A. umbilicata* forms a distinct angle at the junction of the base of the columella and the peristome.

The distribution of these two species is rather interesting. Except at Malaekahana, they are not found together in any colony, although large colonies of *A. umbilicata* have been taken within the region between Kahuku and Malaekahana, from which scattered specimens of *A. problematica* have been found. No specimens of *A. umbilicata* have been reported from the Kawailoa region between the Waimea and the Waialua rivers, and it is in this area that most of the specimens of *A. problematica* have been taken. Probably the species represents a specialized form of the *umbilicata* series that originated in this area.

In none of the localities from which *A. problematica* has been taken is it an abundant species. It never has been taken in as large quantities as has *A. umbilicata* in some of its localities.

Shells from Malaekahana and Kahuku are proportionately broader and more solid than those from Kawailoa. Malaekahana, no. 44805: length, 11.4 mm.; diameter, 6.0 mm.; whorls, 6+. Kahuku Point, no. 77325: length, 11.2 mm.; diameter, 5.8 mm.; whorls, 6.

Subgenus **AMASTRA**Section **AMASTRELLA**Series of *Amastra rugulosa***7. *Amastra (Amastrella) rugulosa* Pease.**

A series of this species in the Pease collection (no. 45255, Museum of Comparative Zoology) has no record of the locality on the label, although in the original description the locality given is Kauai. Baldwin⁴ gives Kapaa as a more exact locality without stating the source of his information. No specimens of this species came to Bernice P. Bishop Museum with the Baldwin collection, though three specimens of *A. rugulosa normalis* labelled "A. Brevis? Wahiawa, Kauai" in Baldwin's handwriting were included in his collection.

Sykes⁵ gives Lihue as the habitat from the identification of specimens collected by Perkins. One of these is in the Bernice P. Bishop Museum collection and is a typical example of *Amastra rugulosa normalis*, which is an abundant species on the slopes of Haupu in Kipu on the southern boundary of the Lihue district, undoubtedly Perkins' locality.

In the Museum collection are two specimens of Pease's original series received from the Museum of Comparative Zoology. One of these measures: length, 12.1 mm.; diameter, 8.1 mm.; whorls, 6.

In the Museum collection is a small series of Amastras taken by Dr. H. St. John and E. P. Hume in 1931 from Hoolulu, a small precipitous valley on the northern side of Kauai. These shells agree in every essential character with those from the Pease collection, except that all are very slightly smaller. The largest, with six whorls, measures: length, 11.2 mm.; diameter, 7.7 mm.

Amastras referable to this species, though not abundant, are found in both the fossil deposits at Limahuli and Haena. Those from Limahuli were collected independently by A. F. Judd, C. S. Dole, W. Meinecke, and C. M. Cooke, Jr. These, like the Hoolulu shells, agree in all characters except size with the shells from the Pease collection. They are proportionately a little narrower than the Hoolulu shells. Three of them, adults, measure: length, 11.7 mm., 11.3 mm., 10.5 mm.; diameter, 7.1 mm., 7.2 mm., 7.2 mm.; whorls, 6 $\frac{3}{4}$, 6+, 6—.

Haena specimens collected by Cooke (1914) near the western

⁴ Baldwin, D. D., Catalogue of land and fresh water shells of the Hawaiian islands, Honolulu, 1893.

⁵ Sykes, E. R., Mollusca: Fauna Hawaiiensis, vol. 2, pt. 4, p. 354, Cambridge, 1901.

extremity of the Haena plain agree closely with those found at Limahuli. Two of them have the following measurements: length, 11.8 mm., 11.5 mm.; diameter, 6.9 mm., 7.4 mm.; whorls 6 + . 6.

Because of the fairly close agreement of these shells with those of Pease, it is safe to assume that those from the Pease collection came from the northern side of Kauai between Wainiha on the east and Limahuli on the west, a portion of the island in which Pease is known to have collected.

7-a. *Amastra rugulosa janeae*, new subspecies (pl. 1, fig. 6).

The shell is longer and proportionately narrower than that of the species, with a longer and more acuminate spire and from one-half to one additional whorl. The perforation is narrow and compressed as in the typical form of the species. In surface texture and color pattern the species and subspecies agree closely. Length, 13.1 mm.; diameter, 7.6 mm.; aperture diagonal, 6.2 mm.; whorls, 6½.

Kauai: Ohia Valley, Anahola watershed west of the Kaneha Reservoir, along ditch trail near bottom of the valley (J. Dranga, T. Dranga, and C. M. Cooke, Jr., 1925). Type no. 10759; paratypes, no. 80793.

Only seven recently dead examples of this subspecies were taken, most of which were found by Mrs. Dranga. Although considerable search was made after finding the first shell, no live ones were obtained.

This subspecies is intermediate between the typical form of *A. rugulosa* and *A. rugulosa annosa* Cooke. *A. rugulosa annosa* is abundant in the coastal Pleistocene deposits 5 to 7 miles to the southeast. From this subspecies *A. rugulosa janeae* differs in its slightly more concave spire and smaller umbilicus. The columellar fold is quite distinct in both forms. In *A. r. annosa*, it is weak and deeply seated. In *A. r. janeae* it is strong and subtransverse and ends abruptly at the outer margin of the columella.

8. *Amastra (Achatinella) anthonii* Newcomb (pl. 1, figs. 8-10).

Achatinella anthonii Newcomb, Proc. California Academy of Nat. Sci. II, p. 93, 1861; American Journ. of Conchology, II, p. 210, pl. 13, fig. 2, 1866.

As the original locality of this species has never been reported, the following notes may be of interest for future collecting on the island of Kauai. Newcomb received his specimens from the Rev. E. Johnson, a missionary located at Waioli, on the northern side of

Kauai, from 1837 to about 1867. Newcomb gives no information except that the species came from Kauai. Bernice P. Bishop Museum is fortunate in having several series which are exactly located and which indicate that this species inhabits the northwestern sector of the island. In addition, there are several small lots which are unlocalized. One series of seven specimens came to the Museum with the J. S. Emerson collection. From the appearance of these shells, it is evident that they were collected several years ago. With one possible exception, all must have been dead when found. As most of the Kauaian land snails in Mr. Emerson's collection, which appear to have been collected 50 to 75 years ago, came from Mr. Johnson, it is fairly safe to assume that these specimens, though not definitely stated, were obtained from him. If my surmise is correct, these are probably a part of Mr. Johnson's original material, a portion of which went to Newcomb. Mr. Emerson's label reads, "*Amas. anthonii*, New., Kalalau, Napali, Kauai." The paper, the faded ink, in fact the whole appearance of the label, are exactly similar to the label of *Carelia cumingiana*, the specimens of which Mr. Emerson told me were obtained from Mr. Johnson, although this is not stated on the label.

This lot of shells contains specimens which agree fairly closely with those mentioned by Newcomb in his description and notes, and also with Newcomb's figure of the species, which he states "is more obese than usual and less elongated."

Three of Mr. Emerson's specimens have the following measurements:

Length	Diameter	Aperture Diagonal	Whorls
18.5 mm.	11.0 mm.	8.8 mm.	6¼
17.8 mm.	10.0 mm.	8.6 mm.	6
16.5 mm.	10.2 mm.	8.1 mm.	6

These measurements are slightly larger than those given by Newcomb (15 by 10 mm.). The apical whorls of some of the shells are slightly more conical and very slightly more flattened than has been observed in any of the localized specimens referred to this species. None of the snails have the coarsely costulate embryos which are characteristic of *Armiella*.

Specimens of *Amastra anthonii* collected by C. S. Dole, and C. N. Forbes (1909) on a spur of the southern side of Kalalau at an ele-

vation of about 1,000 feet agree so closely in size, form, and texture with Mr. Emerson's specimens that it is safe to assume that the type locality was somewhere on the southern slopes of the valley.

Three shells collected by Forbes and Dole (no. 19694) have the following measurements:

Length	Diameter	Aperture Diagonal	Whorls
18.5 mm.	10.6 mm.	8.8 mm.	6 (pl. 1, fig. 8)
16.8 mm.	10.2 mm.	8.2 mm.	6 (pl. 1, fig. 9)
16.3 mm.	9.9 mm.	8.2 mm.	5¾ (pl. 1, fig. 10)

In a few, there is an indistinct angling at the periphery which is distinct enough to modify the form of the aperture slightly.

From additional localities in Kalalau a single specimen taken by Knudsen (1907) at the head of the valley, and another found by Cooke (1907) in the small deep valley near the southwestern margin of the main valley can be included in the typical forms.

8-a. *Amastra anthonii remota* (Cooke).

Amastra remota Cooke: B. P. Bishop Mus. Occ. Papers, vol. 3, no. 3, p. 10, pl. A, fig. 3, 1917.

With the abundance of material now available for comparison and illustrating the wide local and consistent variation of *A. anthonii*, I think that it is appropriate to consider *A. remota* as a subspecies of *anthonii* rather than to accord it specific rank. The wider and flatter embryonic whorls, making a more rounded and less conical apex, form a constant differential character between this subspecies and all the other races, including typical specimens.

8-b. *Amastra anthonii meineckeii*, new subspecies (pl. 1, figs. 7, 11-15).

The shell is consistently longer, more cylindrical in form and proportionately narrower than in typical *A. anthonii*. In surface texture and color pattern, both agree closely. In recent examples the body whorl is maroon, a small region around the umbilicus Naples yellow; the suture is bordered below by an indefinite, narrow, indistinctly yellowish band. The lip-rib is remarkably weak for a shell with its thick heavy texture. Length, 23.2 mm.; diameter, 11.2 mm.; aperture diagonal, 9.7 mm.; whorls, 6¾.

Kauai: Kalalau, on the northern side of the valley, east of double waterfall (Meinecke, 1925, 1927). Type, no. 10764 (pl. 1, fig. 7); paratypes, nos. 86493-5.

Both of Meinecke's series were collected in exactly the same locality on a steep, shrubby slope high up on the precipitous side of the valley. On his first visit only dead specimens were taken, but on the second a few live shells, in addition to several dead ones, were found. Nearly all the specimens agree closely; the only variants are three dead shells which have more conic outlines and are proportionately broader than the majority of specimens. One of these measures: length, 20.0 mm.; diameter, 10.5 mm. Embryos of this subspecies are very similar to embryos of the same age taken from the nearly typical examples collected by Forbes and Dole. In both forms the embryonic shells are narrowly umbilicate, and in addition to the fine, longitudinal striae, there are very faint microscopical spiral lines which are more noticeable below than above the periphery.

Amastra a. meineckei nearly equals *A. ricei* in size. From *A. ricei*, *A. meineckei* differs principally in its more convex and less distinctly sculptured embryonic whorls; and in the series of 21 examples before me there is not the slightest indication of a peripheral keel. In my former paper⁶ I placed *A. ricei* and its variety *armillata* in the section *Armiella* of the subgenus *Kanaia*. Throughout the numerous series of *Amastra anthonii* from many localities the embryonic differences are constant. If these embryonic differences are not over-emphasized, it would be appropriate to consider *A. ricei* a divergent species of *Amastrella* rather than a form of *Armiella*. *A. ricei* is apparently intermediate between these two sections of the genus *Amastra*.

Farther to the east, in the precipitous valley of Hanakoa, Meinecke discovered, in 1927, an interesting colony of what is apparently a local race of *A. anthonii meineckei*. The shells are proportionately much narrower than typical examples of *A. anthonii*, on the average somewhat smaller than *A. anthonii meineckei*, and they represent a race of the subspecies. The largest shells from this colony are nearly the same size as the shortest adults of this subspecies from Kalalau. Three adults (no. 10763) have the following measurements:

Length	Diameter	Aperture	
		Diagonal	Whorls
20.0 mm.	9.7 mm.	8.9 mm.	6½ (pl. 1, fig. 14)
19.0 mm.	10.4 mm.	9.2 mm.	6½ (pl. 1, fig. 13)
17.4 mm.	9.6 mm.	8.2 mm.	6¼ (pl. 1, fig. 15)

⁶ B. P. Bishop Mus. Occ. Papers, vol. 3, no. 3, p. 3, 1917.

Another race of *A. anthonii meinecke*, which was taken in abundance by Meinecke (1925, 1927) at Hoolulu, about a mile and a half east of Hanakoa, in a patch of woods located just above the trail, differs in being considerably smaller than any examples of the subspecies found farther to the west and south. The largest shell, however, is nearly $1\frac{1}{2}$ mm. shorter than the smallest adult from Hanakoa, and the average difference in length between the representatives of these two races would be nearly 4 mm. Most of the shells have about one complete whorl less than the majority of the western representatives of this subspecies. Three shells (no. 10756) representing the extremes of variation in this colony have the following measurements:

Length	Diameter	Aperture Diagonal	Whorls
16.0 mm.	9.0 mm.	7.7 mm.	6 (pl. 1, fig. 11)
15.0 mm.	8.1 mm.	6.8 mm.	6+
13.3 mm.	7.6 mm.	6.7 mm.	$5\frac{2}{3}$ (pl. 1, fig. 12)

Unfortunately, none of Meinecke's material was taken alive. The smallest specimen, of which the measurements are given above, shows some approach in size to the form identified by nearly all authors and collectors as *A. nucleola* Gould. From specimens of *A. nucleola* this small example of the new subspecies differs in its more cylindrical form, thicker shell, and much more strongly striated surface.

8-c. *Amastra anthonii subglobosa*, new subspecies (pl. 1, fig. 16).

The shell is larger than typical examples of the species, with a more capacious and proportionately wider last whorl. The spire is much wider in proportion to its length than in any specimen of *A. anthonii* which has been examined, and it has slightly more convex and rapidly increasing whorls. The surface is less distinctly longitudinally sculptured and the spiral lines are very weak. Length, 17.9 mm.; diameter, 11.2 mm.; aperture diagonal, 9.0 mm.; whorls, 6.

Kauai: Waimea (A. F. Judd, 1892). Type, no. 10757; paratypes, no. 17973.

The original and only series of this subspecies which I have seen consists of three adults and two juveniles, all dead when collected. This series came with a number of other species labelled "Waimea, Kauai." Waimea is a more or less generic locality and includes the southwestern portion of Kauai. Several of the species can be defi-

nately identified as coming from particular localities, as they are known to inhabit rather restricted areas. Other species are present which are found in many portions of Kauai and cannot be assigned to any particular locality. The exact habitats of two or three of the species in this lot are, at present, unknown, for they have not been rediscovered by any recent collector. *A. anthonii subglobosa* is one of these. From its rather intimate relationship to *A. anthonii* from the southern side of Kalalau, it is safe to assume that the specimens of *A. a. subglobosa* were taken from above the cliffs in one of the upland branches of the valleys of Honopu, Nualolo, or Milolii.

The shell chosen as the type differs slightly from the other two adults, as there is a faint, indistinct angle at the periphery which is not indicated in the other two, which unfortunately were in very poor condition when collected.

The separation of *A. a. subglobosa* is based largely on characters of juveniles. In comparison with *A. anthonii* of similar age, typical specimens of *A. a. subglobosa* have a proportionately wider and much shorter spire, with more convex outlines, and, in addition, much more convex individual whorls. Two juveniles have the following measurements:

	Length	Diameter	Aperture Diagonal	Whorls
~	15.2 mm.	10.2 mm.	8.5 mm.	5½
	13.5 mm.	10.2 mm.	8.1 mm.	5¼

A juvenile *A. anthonii* from the southern side of Kalalau (no. 19960) in the Museum collection measures: length, 15.9 mm.; diameter, 9.5 mm.; aperture diagonal, 8.1 mm.; whorls, 5¾.

9. *Amastra* (*Amastrella*) *ovatula*, new species (pl. 2, figs. 5-7).

The shell is distinctly though very narrowly perforate, ovately conic to conic, in its dead state dull white except for the embryonic whorls which are indistinctly bicolored whitish and cinnamon-rufous. The spire has slightly convex to nearly straight outlines, modified to a certain extent by the convex post-embryonic whorls, and has a rather narrow apical cone. The embryonic whorls are convex, nearly smooth, under a strong lens indistinctly striate; the post-embryonic whorls increase in convexity with the growth of the shell, their surfaces covered with strong, closely packed, irregular striae; the interstices between the striae marked with fine, close, spiral lines. The last whorl is oblong in some specimens to shortly ovate in others. The aperture is sub-ovate, its outer margin regularly curved and distinctly thickened. The colu-

mella is nearly straight, very narrowly triangular. Columellar lamella fine, low, oblique, ending gradually before reaching the outer margin of the columella. The umbilicus is very narrow, but open. The measurements of five adult cotypes are as follows:

Length	Diameter	Aperture Diagonal	Whorls
16.3 mm.	8.8 mm.	7.6 mm.	6¼ (pl. 2, fig. 5)
14.8 mm.	8.7 mm.	7.0 mm.	6
13.3 mm.	8.4 mm.	6.6 mm.	5¾ (pl. 2, fig. 6)
12.6 mm.	8.2 mm.	6.3 mm.	5¾ (pl. 2, fig. 7)
12.5 mm.	8.2 mm.	6.3 mm.	5¾

Kauai: abundant in Pleistocene deposits near the western edge of the Haena plain (C. M. Cooke, Jr., 1914-1923), comparatively rare in deposits of similar age at Limahuli (C. M. Cooke, Jr., 1907). Cotypes, no. 10758; paratypes, no. 37537.

Amastra ovatula, as represented in Bernice P. Bishop Museum from the type locality, shows a great deal of variability not only in size and form, but also in the degree of convexity of the post-embryonic whorls and in the outlines of the spire. From the presence of a distinct narrow umbilicus in all but a very few specimens, I was inclined to consider this species as an aberrant form of *Cyclamastra*. Except for this single character the species should be placed near *A. anthonii*, to which it has undoubtedly a close relationship. *A. ovatula* differs from *A. anthonii* not only in that most of its examples are perforate, whereas all *A. anthonii* are imperforate, but also in its somewhat narrower embryonic cone, the whorls of which are more convex. In addition, the post-embryonic whorls are decidedly more convex than in any shells which have been examined that could be attributed to *A. anthonii* or any of its races. There is, however, one character which is common to both species, namely, the presence of fine, spiral lines between the longitudinal striae of the last two and a half whorls. In common with *anthonii* and a few other Kauaian *Amastras*, the columellar fold is weak and does not extend to the outer margin of the columella.

Although a number of the shells from Limahuli agree closely with those from Haena, some have slightly flatter post-embryonic whorls.

Section METAMAstra

Series of *Amastra reticulata*10. *Amastra* (*Metamastra*) *gulickiana dichroma*, new subspecies,
(pl. 2, fig. 8).

The shell is indistinctly perforate, ovately to globosely conic, thin, scarcely shining, above the periphery and in back of the aperture claret brown shading to lighter above, glossier and of an old gold to buffy citrine color below the periphery and in front of the aperture. The spire is broadly conic with convex outlines. The embryonic whorls are proportionately large, increasing rapidly, nearly smooth; post-embryonic whorls are slightly convex, regularly and closely marked with fine growth-wrinkles. The aperture is broad, its outer margin regularly curved, furnished within with a delicate lip-rib and forming, below, an angle with the base of the columella. The columella is nearly straight, furnished near its base with a rather strong slightly oblique fold which terminates near the outer margin of the columella.

Length	Diameter	Aperture		Whorls
		Diagonal		
12.0 mm.	7.5 mm.	6.0 mm.	6	(Type, dead, adult)
11.3 mm.	7.3 mm.	5.8 mm.	5½	(Dead, adult)
11.1 mm.	7.4 mm.	5.5 mm.	5¾	(Alive, nearly adult)

Oahu: on both sides near the crest of the ridge between Punaluu and Kaluanui (O. Oswald, 1929, 1930); on division ridge between Helemanu, Waikane, and Kahana (O. Oswald, 1929). Type, no. 10748, and paratypes, nos. 100662, 100663, B. P. Bishop Museum collection; also paratypes in Oswald's collection.

This subspecies is evidently an extremely rare form, of which about 30 examples are the result of six findings. It is remarkable that this subspecies has not been taken by other collectors, as the trail along which Mr. Oswald found his specimens has been well known to most collectors and frequently visited for the last 25 years. This locality is separated by 4 or 5 miles from the habitat of *A. gulickiana*, which has only been taken on the southern side of the range. The subspecies *A. g. dichroma* agrees with typical *A. gulickiana* in the embryonic form and whorling. It differs in its slightly larger size, less globose form, the finer and more regular striation of the post-embryonic whorls, and the indistinct keel on the periphery. Two live shells taken by Oswald on the crest of the ridge between Punaluu and Kaluanui are not bicolored. One of them is of a nearly uniform bay color, the second is of nearly uniform antique brown; otherwise, they agree with the type specimens found a few hundred yards to

the south. The shells taken on the Punaluu side of the ridge, as well as those from the Waikane-Kahana ridge, agree in color pattern with those from the type locality. A few show a slight color variation in that the sutures of the last two whorls are accompanied below by an indistinct, rather broad, lighter colored band. Juveniles with about four and one-half whorls are narrowly umbilicate. The third specimen, which is not quite mature, as the thickening of the peristome has only taken place near its base, was pregnant with one embryo. This embryo is nearly globose, with about two and one-half whorls; the spire is low-convex. It is distinctly perforate and has, near the base of the columella, a very low, indistinct swelling indicating the position of the columellar fold.

In addition to the type specimen of *A. gulickiana*, the Museum collection contains three lots which have been acquired since the publication of volume 23 of Pilsbry's Manual of Conchology (1915). Two lots, containing three dead and worn specimens, are typical of *A. gulickiana*. The first was collected by W. Meinecke in 1930 at Opauala, and the second was collected by O. Oswald at Helemano. The third lot contains four shells which in color pattern, size, and form are close to *A. g. dichroma*. These were collected by A. Gouveia in 1916. From the appearance of all of the specimens at hand, it is probable that *A. gulickiana* is an inhabitant of the somewhat dry forest zone on the south side of the Koolau Range. While *A. g. dichroma* inhabits the damp rain forest on both sides of this range, both the species and subspecies are limited to the northern or nearly northwestern end of the Koolau mountains.

11. *Amastra* (*Metaastra*) *subrostrata* (Pfeiffer) (pl. 2, fig. 9).

Pilsbry has dealt rather fully with this species⁷ and has reproduced a figure of the type specimen. As he had not examined localized material, the following notes may be of interest. During 1923 Oswald collected several fine series of a species which I did not recognize. They were found to agree closely with Pfeiffer's description, Pilsbry's figure, and also with one of Pease's specimens of *A. solida* received from the Museum of Comparative Zoology, which, according to Pilsbry, equals *A. subrostrata*. With this clue as to the identity of *A. subrostrata*, a reëxamination of the *Amastra* material from this region was made and an additional lot of the species was

⁷ Pilsbry, H. A., Manual of Conchology, vol. 23, p. 28, pl. 7, fig. 4, 1915.

found. This last lot I had collected in a small valley near the crest of the Waianae Mountains east of Mauna Kapu. Oswald's material, the result of three trips, was collected in Nanakuli Valley, the southernmost large valley on the western side of the Waianae Mountains. The shells were found on the precipitous slopes of the head of the valley between the two peaks of Mauna Kapu and Palikea, at from one-half to two-thirds of the altitude above the floor of the valley. In 1931 Cooke and Welch took this species about 200 to 300 feet below the crest of the range on the Nanakuli side, probably directly above Oswald's localities. All the live specimens were taken in "leaf trash" under trees and shrubs, in both dense and open forest.

From what is known at present of the distribution of *Amastra subrostrata*, the species is, for the most part, living today in the northeast corner of Nanakuli Valley with a few examples found on the eastern side of the range almost opposite the more abundant western colonies.

In fresh shells, one of which is figured, the whorls, except the last, are of a uniform russet to cinnamon-brown. In most shells the outer surface of the cuticle of the last whorl is indistinctly marked with vertical and spiral small grayish patches so that this whorl is almost Hay's brown in color. This shades into a chamois to honey yellow color on the last whorl in back of the peristome. A very few shells are almost uniformly colored similar to Pilsbry's figure of the type. A large majority are of about the dimensions given by Pfeiffer (length, 15 mm.; diameter, 8 mm.). A few dead shells are slightly larger. One of them measures: length, 17.0 mm.; diameter, 8.2 mm.; aperture diagonal, 7.2 mm. (pl. 2, fig. 9).

11-a. *Amastra (Metamastra) subrostrata acuminata*, new sub-species, (pl. 2, fig. 10).

The shell is elongate with a proportionately long spire which has convex outlines below, concave above. In color and form of aperture *A. s. acuminata* agrees fairly closely with typical *A. subrostrata*.

Length	Diameter	Aperture Diagonal	Whorls
20.0 mm.	8.7 mm.	8.1 mm.	7+
19.2 mm.	9.0 mm.	8.2 mm.	7 (pl. 2, fig. 10)

Oahu: Waianae Mountains, Lualualei, southeast side of valley, high up the sides in damp glen (O. Oswald, 1928). Cotypes,

no. 10773; paratypes, no. 91998. *A. s. acuminata* is considered of subspecific rank on account of its length and the differences in the outlines of the spire. In addition, it invariably has nearly a whole additional whorl.

In the three trips made by Oswald, nearly 100 living and dead examples of this form were taken. All agree closely in size and other characteristics, except one dead shell which has almost the same dimensions as the dead specimen of the typical *A. subrostrata* mentioned above.

12. *Amastra* (*Metamastra*) *oswaldi*, new species (pl. 2, fig. 13).

The shell is imperforate, sinistral, oblong-conic, somewhat solid, the post-embryonic whorls finely sculptured with oblique, slightly flexuous growth-striae. The embryonic whorls are warm blackish brown, post-embryonic whorls with tawny-olive ground color covered with a thin, nearly black cuticle arranged in narrow vertical stripes which coalesce on the back of the last whorl. There is no cuticle in front of the aperture. Spire conic with nearly straight outlines, the apical whorls nearly flat, the rest only slightly convex, the last subcylindrical. Aperture rather narrow, subvertical, the outer margin narrow, distinctly edged with black and furnished with a narrow lip-rib. Columella short, terminated abruptly by a twisted fold. Length, 16.6 mm.; diameter, 8.6 mm.; aperture diagonal, 7.0 mm.; whorls, 6½.

Oahu: close to the crest of the Kualoa ridge east of Puu Kanehoalani (O. Oswald). Type, no. 10771; paratypes, no. 92276. This species is exceedingly rare and was taken by Oswald in the clumps of kukui trees near the crest of the ridge. The result of six trips to this difficult and dangerous locality netted about 30 specimens. No live shells were taken, and only three had the color and cuticle perfectly preserved. The great majority were bleached and white.

There can be no confusion between the identity of this species and that of *Amastra thaanumi* found under similar conditions on the opposite ridge of Kaaawa. *A. oswaldi* is longer, proportionately narrower with flatter and more closely-coiled whorls. It is, however, in the embryonic whorls that the two species are entirely unlike. Those of *Amastra thaanumi* increase rapidly, forming an obtuse apex, whereas those of *Amastra oswaldi* increase slowly and are flattened, forming a sharp cone.

Amastra oswaldi is probably on the verge of extinction, as the native forests of its habitat occupy only the apices of the steep hanging valleys on the northern side of the ridge. There is but very little variation in the form of the shells. A few are slightly more conical,

with slightly broader aperture than the type. Of the two additional shells with perfectly preserved cuticle, one is almost similar to the type. In the other, the alternating stripes are much broader.

Section AMASTRA, sensu stricto

Series of *Amastra assimilis*

13. *Amastra inopinata*, new species (pl. 2, figs. 11-12).

The shell is imperforate, subcylindrical, solid, and, in its dead state, white. The spire is narrowly ovate, with a rather blunt apex. The embryonic whorls increase rapidly, are nearly flat, and the first two are strongly engraved with the characteristic axial costae of *Amastra*, sensu stricto. In some examples, beginning on the third whorl and just before the embryo is fully formed, these costae are intercepted near their middle with a series of flattened planes. The surface of the post-embryonic whorls, especially of the lower, is distinctly and strongly malleate, the planes being slightly modified by growth-wrinkles. The post-embryonic whorls are flatly convex, separated by a simple, scarcely impressed suture. The last whorl is subcylindrical, tapering slowly toward the base. The aperture is longer than broad, its outer margin slightly curved, becoming more strongly curved below. Columella only slightly twisted, furnished near its middle with a strong oblique fold.

Length	Diameter	Aperture Diagonal	Whorls
18.6 mm.	9.1 mm.	8.1 mm.	6¼ (Cotype; pl. 2, fig. 11)
17.5 mm.	9.2 mm.	8.0 mm.	6⅓ (Cotype; pl. 2, fig. 12)

East Maui: Kula, near the division between the lands of Keokea and Kamaole (C. M. Cooke, Jr., 1922). Cotypes, no. 10769; paratypes, no. 52838. All the shells came from an extremely rocky pasture extending between the upper and lower roads. Scattered through this pasture are a few dying trees, the last remnants of the native forest of a few decades ago. Many dead land shells of several species and genera were found scattered among the loose surface stones. Under a single stone about two or three quarts of the richest fossiliferous earth were uncovered. From this mass of earth about 1,300 whole or nearly whole shells were picked out with representatives of about 70 species belonging to 23 genera. All the specimens of *A. inopinata* were found under this stone except one, which was taken about one-fourth of a mile directly above this locality on the previous day. Undoubtedly this region was inhabited by a rich land snail fauna sometime within the last hundred years. A large number of these species must be entirely extinct, as no native forest area is located within several miles.

The most distinctive characters of this species, characters in which it differs from the rest of the *Amastras* of Maui, are the width and rapid increase of embryonic whorls. These form a very wide cone at the apex of the shell. In all the other Mauiian species of *Amastra* the apical cone is much narrower and decidedly more pointed. *Amastra inopinata* also differs from the other species from Maui in its cylindrical form. The malleate surface texture is not limited to this species, but is also found in a few others from Maui. In size and proportions *A. makawaoensis* about equals *A. inopinata*, but *A. makawaoensis* is easily separated by its more narrowly conic apical whorls and spire.

Section HETERAMAstra

14. *Amastra* (*Heteramastra*) *dwrightii*, new species (pl. 2, fig. 14).

The shell is imperforate, sinistral, ovate-turrite, thin, dull, Saccardo's umber, more or less streaked with lighter color. Spire conic, with slightly concave outlines above. Embryonic whorls convexly flattened, somewhat carinate at the periphery, separated by a deep, narrow suture, regularly engraved with distinct close costae. Post-embryonic whorls slightly convex, separated by a distinct suture, marked with fine, uneven growth-striae, and slightly carinate at the periphery, the carination bounding the upper margin of the suture. Last whorl proportionately very large, ovate. Aperture narrowly ovate, its outer margin regularly curved and furnished with a distinct delicate lip-rib. Columella oblique, short, furnished near its middle with a stout oblique fold. Length, 9.3 mm.; diameter, 5.4 mm.; aperture diagonal, 4.3 mm.; whorls, 6.

East Maui: Hana (D. D. Baldwin collection). Type, no. 10766; paratypes, no. 55608. The series of this species consists of five specimens which came to Bernice P. Bishop Museum with the Baldwin collection. The original label in Baldwin's characteristic handwriting is "Amas. soror? Ne., Hana? Maui." There is no clue as to whether Baldwin collected the shells or received them from some one else, as the space for the name of the collector is left blank in his catalogue.

This is the smallest species of those that can be included under Pilsbry's section *Heteramastra*. There is no very distinctive character except the small size and strongly and evenly sculptured embryonic whorls. *Amastra dwrightii* does not seem to belong to any known species as a subspecies or geographical race.

Of the five specimens making up the original series three are

adult, and two, in which the lip-rib shows a slight thickening along its lower margin, are nearly so. One of these two, which has five and one-half whorls, has a length of just 8 mm. All five shells agree in the evenness and degree of sculpturing of the embryonic whorls. In three there is an indication of a peripheral keel on the second embryonic whorl, whereas in two this keel is strongly developed. Each of the shells has a distinct, though not strongly developed, peripheral keel on all the post-embryonic whorls except the last.

In general form and proportions, *A. dwightii* has somewhat the appearance of a diminutive *A. fraterna* from Lanai or *A. subsoror awahiensis* from the southern slopes of east Maui. It differs from *A. fraterna* in its proportionately shorter and less attenuate spire and coarser embryonic sculpture, and from *A. subsoror awahiensis* in its less convex post-embryonic whorls and in the flatter and much more distinctly sculptured embryonic whorls.

15. *Amastra (Heteramastra) implicata*, new species (pl. 2, fig. 15).

The shell is imperforate or minutely rimate perforate, sinistral, oblong-conic, with convex outlines, deep olive buff, covered with a thin, Dresden brown to mummy brown epidermis. In most of the examples the cuticle is arranged in a fine, reticulate pattern on the spire, but in a few the cuticle forms a nearly uniform, slightly streaked covering. Spire narrowly conic, with slightly convex outlines, attenuate above and ending in a sharp apex. Embryonic whorls nearly flat, the initial whorl strongly marked with sharp, rather coarse costae. With the growth of the embryo, the costae become slightly weaker and more closely packed. The periphery of the embryonic whorls is marked with a strong, sharp, distinct keel which extends over the suture. Post-embryonic whorls are somewhat convex, the surface (under a lens) marked with fine, irregular, closely spaced growth-striae. The last whorl is sub-cylindrical, tapering gradually and evenly to the base, its last half descending slowly and regularly below the periphery of the penultimate whorl. Aperture slightly contracted, narrow, its outer margin regularly curved and furnished with a thin, hardly discernible lip-rib. Columella rather short, oblique, furnished near its middle with a strong, compressed oblique fold.

Length	Diameter	Aperture Diagonal	Whorls
13.0 mm.	6.8 mm.	5.8 mm.	6¼ (Cotype; pl. 2, fig. 15)
12.0 mm.	6.6 mm.	5.4 mm.	6+ (Cotype)

East Maui: Kipahulu, ridge on south side of valley (C. N. Forbes, 1919), type locality; also on the north side of the main valley in the branch valley of Alaenui (C. N. Forbes, 1919). Cotypes, no. 10767; paratypes, nos. 48971-2. In two embryonic specimens from different

individuals the shell is imperforate, the columella is straight, the columellar fold is long, very narrow and delicate, almost vertical, and forms the upper portion of the inner face of the columella. In a juvenile with slightly more than five whorls the periphery is rounded.

This species occupies a more uncertain position than that which is occupied by *Amastra pilsbryi*. In *A. pilsbryi* the apex is slightly rounded and the embryonic whorls are slightly convex, whereas in *A. implicata* the embryonic whorls form the sharp cone with flat embryonic whorls characteristic of typical *Amastra*. The resemblance to typical *Amastra* is also increased by the figured cuticle of the majority of the shells.

On account of the type of columellar fold I am considering this species as belonging to *Heteramastra*, as this character is constant in the embryos of at least four species typical of this section. Unfortunately, the Museum does not have embryos of all the species that have been included in *Heteramastra*. However, I have been able to examine embryonic specimens of *A. fraterna* from Lanai, of *A. nubigena* and *A. subsonor* from West Maui, and of *A. laeva* and *A. subsonor awahiensis* from east Maui. In all of these the columellar fold is delicate, thin, and placed almost vertically along the inner face of the columella.

A. implicata differs from *A. pilsbryi* in its narrower conical form and more attenuate spire and its flatter embryonic whorls. From *A. subsonor awahiensis* it differs in its larger size, more convex outlines, proportionately shorter and less acuminate spire.

16. *Amastra* (*Heteramastra*) *nannodes*,⁸ new species (pl. 2, fig. 16).

The shell is usually imperforate, rarely minutely rimate-perforate, sinistral, narrowly ovate or elliptical, somewhat solid, and, in its dead state, white. The spire is narrowly ovate, with convex outlines ending above in a blunt apex. The embryonic whorls are wide, slightly convex, and increase rapidly. The initial whorl is engraved with coarse, curved, axial costae; the subsequent embryonic whorls are marked with fine, close, delicate striae. The post-embryonic whorls are marked with distinct growth-striae which are more or less modified by spirally descending, low ridges giving the surface a malleate appearance. The last whorl is elongate, subcylindrical, with convex outlines. The aperture is longer than broad, almost elliptical, its outer margin regularly curved and furnished with a wide, distinct lip-rib. The columella is obliquely inclined and furnished near its middle with a strong spirally ascending fold.

⁸ *πανωδης* = like a dwarf.

Length	Diameter	Aperture		Whorls
		Diagonal		
13.2 mm.	7.1 mm.	5.7 mm.		5 $\frac{1}{8}$ (Cotype; pl. 2, fig. 16)
12.0 mm.	6.7 mm.	5.4 mm.		5 $\frac{1}{4}$ (Cotype)
11.9 mm.	6.7 mm.	5.4 mm.		5 $\frac{1}{4}$ (Cotype)

East Maui: Kula, near the division between the lands of Keokea and Kamaole (C. M. Cooke, Jr., 1922). Cotypes, no. 10768; paratypes, no. 52846. All the specimens (nearly 50) of this species were taken from under a single rock. (See *A. inopinata*.)

Amastra nannodes has almost the same size and proportions as *A. pilsbryi* from west Maui. It is easily distinguished from *A. pilsbryi* by its more elliptical and blunter spire and thicker shell, the surface of which is distinctly malleate in the best-preserved specimens.

Like *A. pilsbryi*, *A. nannodes* occupies an intermediate position between typical *Heteramastra* and *Amastra*, *sensu stricto*. My first thought was that it should be classed with typical *Amastra*; but although the embryos are distinctly costate none of them showed the peripheral keel characteristic of most of the species of *Amastra*. In addition, the columellar fold is more obliquely inclined than in most typical *Amastra*, but not as decidedly so as in many species of *Heteramastra*. In embryonic specimens of *A. nannodes* the shells are perforate, the columella fold is rather low and thickened and placed spirally on the columella. Further divergences from *Heteramastra* are the form of the embryo and the thicker shell, which has a distinctly malleate surface. This malleate surface is noticed in a few specimens of *A. laeva* received from Mr. Baldwin.

A. mirabilis, a sinistral species, in the form and sculpture of the embryonic whorls, is distinctly unlike any *Heteramastra* but similar to typical *Amastra*. The obliquity of the columellar fold is between that of typical *Amastra* and that of *A. nannodes*.

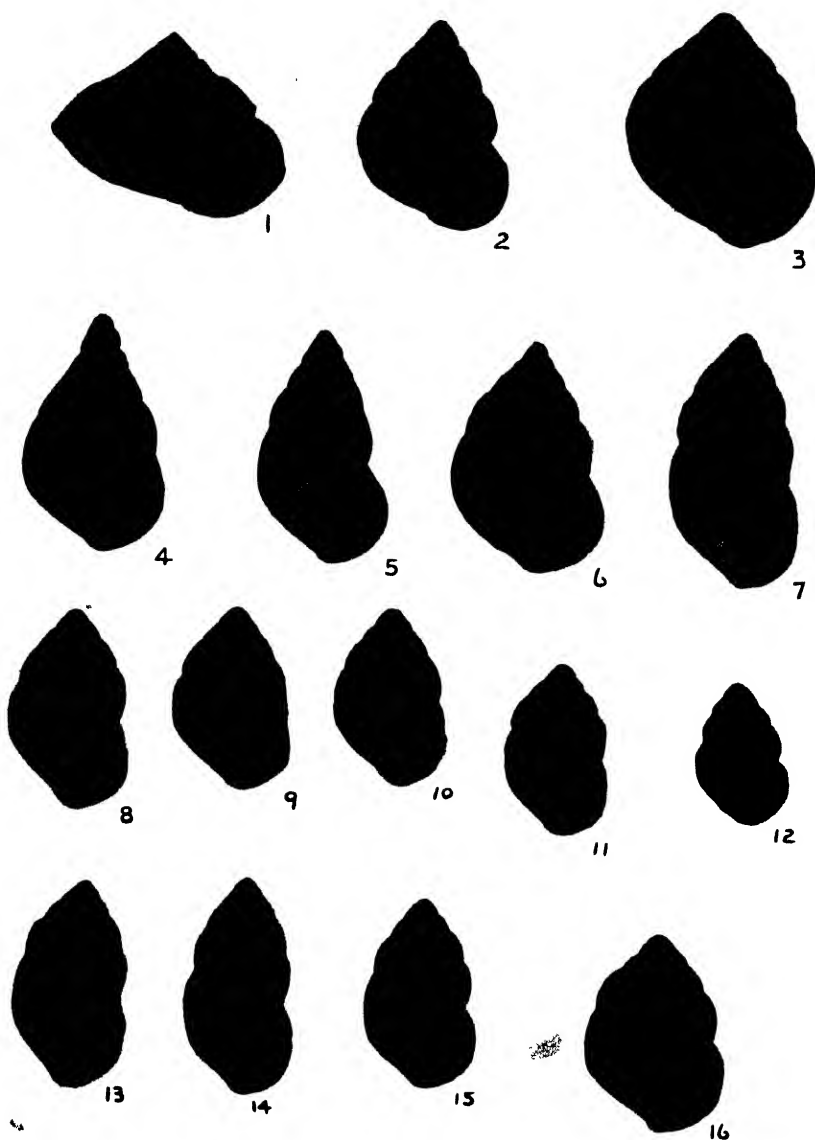
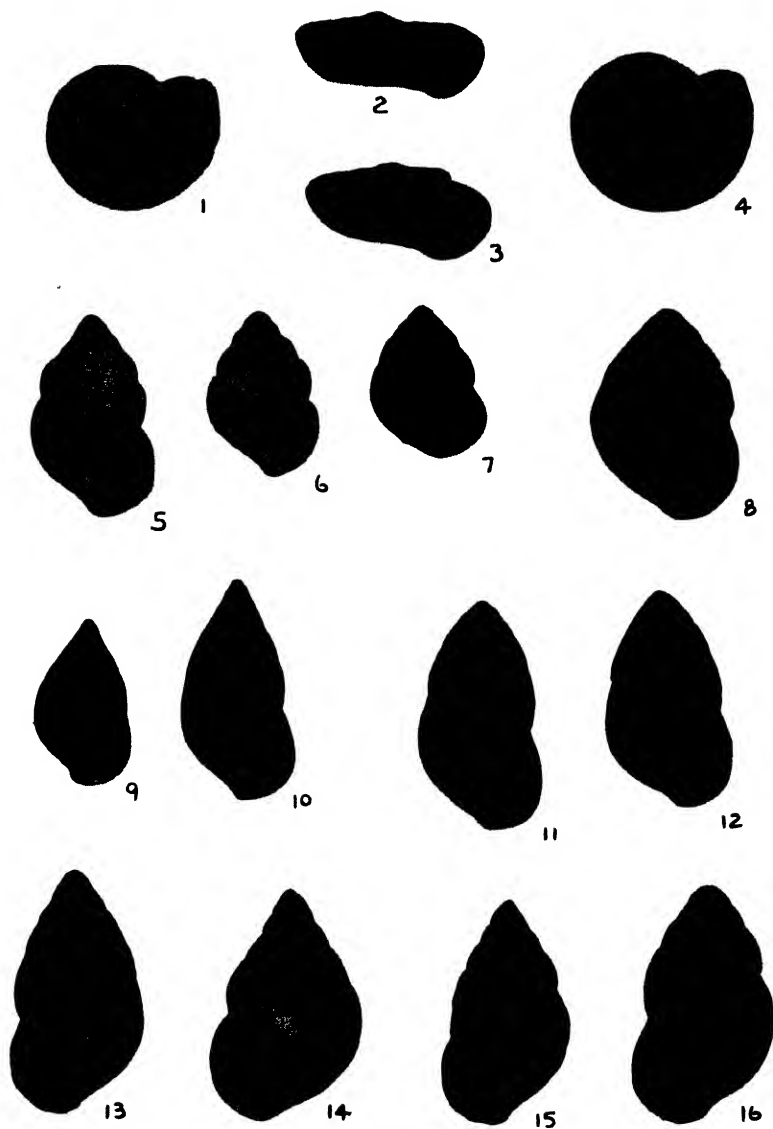


FIG. 1, *Amastra cyclostoma gregoryi* (natural size); FIG. 2, *A. delicata* ($\times 3$); FIG. 3, *A. globosa* ($\times 1.8$); FIG. 4, *A. thurstoni bembicodes* ($\times 3$); FIG. 5, *A. problematica* ($\times 3$); FIG. 6, *A. rugulosa janeae* ($\times 2.5$); FIG. 7, *A. anthonii meinecke* ($\times 1.5$); FIGS. 8-10, *A. anthonii* ($\times 1.5$); FIGS. 11-15, *A. anthonii meinecke* ($\times 1.5$); FIG. 16, *A. anthonii subglobosa* ($\times 1.5$).



FIGS. 1, 2, *Paramastra spaldingi* ($\times 4$); FIGS. 3, 4, *P. spaldingi koolauensis* ($\times 4$); FIGS. 5-7, *Anaestra ovatula* ($\times 1.8$); FIG. 8, *A. gulickiana dichroma* ($\times 2.7$); FIG. 9, *A. subrostrata* ($\times 1.6$); FIG. 10, *A. subrostrata acuminata* ($\times 1.6$); FIGS. 11, 12, *A. inopinata* ($\times 1.8$); FIG. 13, *A. oswaldi* ($\times 2$); FIG. 14, *A. dwightii* ($\times 3.4$); FIG. 15, *A. implicata* ($\times 2.5$); FIG 16, *A. nannodes* ($\times 2.7$).

NOTES ON PTERALYXIA

By

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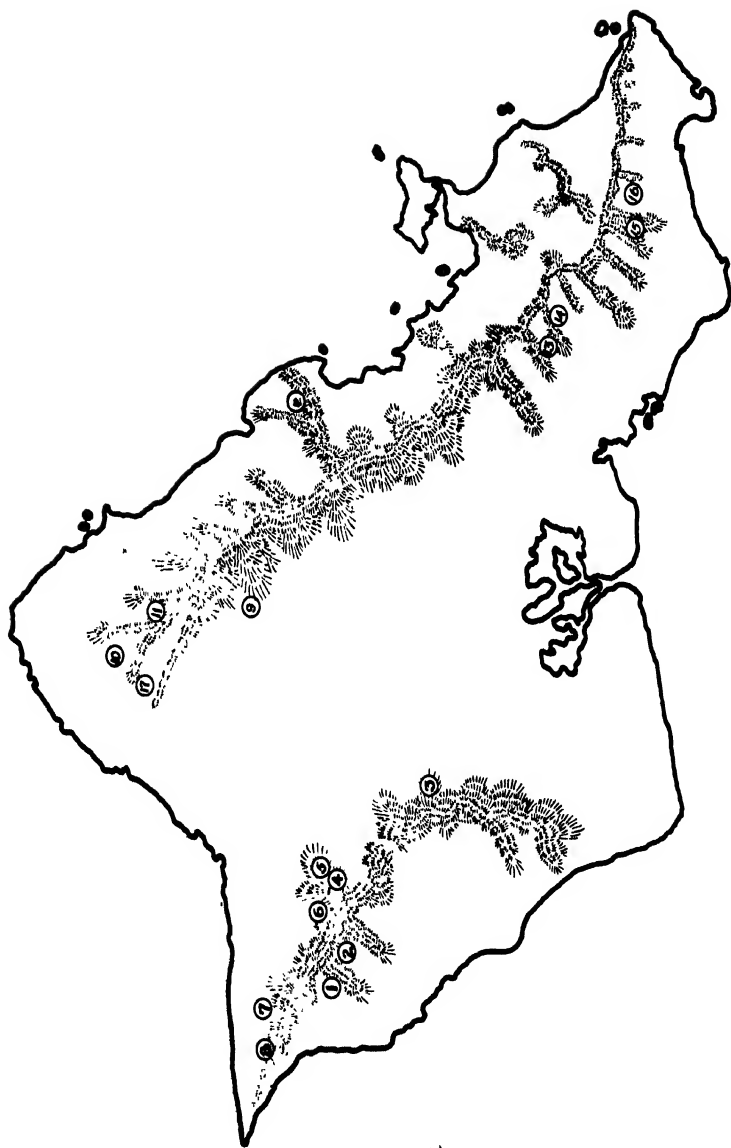


FIGURE 1.—Outline map of Oahu showing the known distribution of *Pteralyxia macrocarpa*: 1, Makua; 2, Makaha; 3, Kanehoa; 4, Haleaiau; 5, Puu Pane; 6, Makaleha; 7, Mokuleia; 8, Kawaihapai; 9, Wahiawa gulches; 10, Kaunala and Pupukea; 11, Laie; 12, Kaaawa; 13, Kalihi; 14, Nuanu; 15, Waialae-iki; 16, Wai-luæ; 17, Waimea.

NOTES ON PTERALYXIA

By

EDWARD L. CAUM

EXPERIMENT STATION, HAWAIIAN SUGAR PLANTERS' ASSOCIATION

***Pteralyxia macrocarpa* (Hillebrand) K. Schumann.**

Hillebrand¹ referred to the American genus *Vallesia* a tree found by him on the island of Oahu which he described as a new species, *V. macrocarpa*. The two rather widely separated type localities were given as Nuuanu Valley in the Koolau Range, and Makaleha Valley, some 25 miles distant, in the western part of the Waianae Mountains. Schumann² separated this species from *Vallesia* and made it the type of the new monotypic genus *Pteralyxia*.

After Hillebrand's time there is no record of the collection of the tree until 1909, when C. N. Forbes found specimens in two places, Makaha Valley in the Waianae Mountains and Kaaawa Valley in the Koolau Range. In 1910 the Abbé Faurie found trees at "Wai-anai," probably in Makaha Valley, where Forbes had collected them the year before. From then on, especially since 1924, trees of this species have been found in many places in both the Koolau and Wāianae mountains on Oahu, and a closely allied species in the Hii mountains on Kauai. The trees are inhabitants of the rain-forests, at elevations of about 700 to 1800 feet, associated with *Metrosideros*, *Maba*, *Pterotropia*, *Tetraplasandra*, *Pittosporum*, and others. The map (fig. 1) shows the distribution of *Pteralyxia macrocarpa* on Oahu as it is known today.

Most of the herbarium material that I have seen was correctly determined, but two collections had been referred to *Ochrosia*. It is known that the same mistake has been made from time to time in the field. Such errors arose, however, only when the flowers were not found or the fruits not dissected, as the characters of either, particularly and more immediately the fruit characters, will separate these two genera at once.

The material on which Hillebrand based the species *P. macrocarpa* came from two widely separated localities and, judging by the type and cotype material in the Bernice P. Bishop Museum herba-

¹ Hillebrand; W. F., *Flora of the Hawaiian islands*, pp. 297-298, Heidelberg, 1888.

² Schumann, K. M., *Monograph of the Apocynaceae*, in Engler and Prantl, *Die natürlichen Pflanzenfamilien*, Teil 4, Abt. 2, pp. 151-152, Leipzig, 1897.

rium, the original collections represent almost the extremes in leaf variation in what appears to be a very variable species. Unfortunately, type fruiting material is not available, and the only knowledge

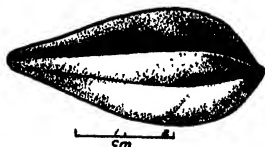


FIGURE 2.—Pyrena of *Pteralyxia macrocarpa* (after Schumann).

I have of the shape of the pyrenae is derived from the illustration in Schumann's monograph.³ This drawing was undoubtedly made from one of Hillebrand's specimens, but there is no notation as to whether it came from Nuuanu or Makaleha. Material collected in Makaleha by Rock, unfortunately not in fruit, shows leaves that differ distinctly from those of Hillebrand's collection from the same general locality. The Nuuanu station has not been rediscovered, and the single tree found in Kalihi Valley, which may possibly be the same form, is so decrepit that it is highly improbable that it will ever bear fruit.

It is fortunate that Hillebrand's original material represented almost the extremes of variation, as the description drawn therefrom is a composite to which any of the Oahu forms may be fitted, although many of these forms may rather easily be distinguished one from the other. Hillebrand makes no mention, however, of the lacy perforations in the crests of the pyrenae which characterize all the forms thus far known from Oahu except that from Haleauau and the one from which Schumann's drawing was made. This seems to indicate that Hillebrand's material from one of his stations was incomplete and did not include fruits. Judging from the material on hand today, it is hardly probable that the two original collections would have had identical pyrenae.

The flowers of *Pteralyxia* are small and inconspicuous and, judging from my experience and from the herbarium material at hand, difficult to find. Those that I have seen, however, afford no characters by which the different forms may be distinguished. The fruits

³ Op. cit., p. 152, fig. 56, H. J.

likewise are alike, to all intents and purposes. They vary somewhat, it is true, but the differences are well within a normal range of variation. In this connection, the generic description, adapted by Schumann from Hillebrand's specific description and from his herbarium material deposited in the Berlin Museum, should be corrected in one particular. The fruits are not dry, as stated, but fleshy and solid, the flesh being orange in color and in consistency rather like that of a green apple. The description of the crests of the pyrena is not strictly accurate, but as there is no other Hawaiian genus with pyrenae sufficiently similar to cause confusion, it will serve.

The leaves vary in shape from obovate to obovate-spatulate. The obovate leaves are about 90×50 mm. in size, the obovate-spatulate about 225×65 mm.; respective length to breadth ratios are 1.6 : 1 and 3.5 : 1. Hillebrand gives the range as somewhat greater, 75 to 225 mm. in length and 38 to 100 mm. in width. I have, however, examined no mature leaves quite as short as that lower limit, or as wide as his upper limit. As a general thing, the forms with the longer obovate-spatulate leaves are found in the Koolau Range and those with the shorter obovate leaves in the Waianae Mountains, but this is not a fixed rule, as the Nuuanu and Kalihi forms have the shorter leaves and both leaf types are found in Haleaiau and Makaleha. Some of the leaves on the Pupukea trees tend strongly toward the obovate, though the great majority are distinctly obovate-spatulate, and one specimen from Haleaiau shows both types on the same twig. The other material at hand is uniform for the specimen. The leaf bases vary from broadly to narrowly cuneate, and the tips from obtusely pointed through the rounded to somewhat emarginate. The petioles range in length from 20 to 50 mm., averaging about 31.5 mm. Hillebrand gives the range as 13 to 50 mm. The leaves in all forms are coriaceous, the veins prominent beneath, the midrib especially so, and channeled above, the nerves perpendicular to the costa, parallel, and joined by an intramarginal nerve. The leaf edges are very strongly revolute in the Pupukea form, less so to very slightly in the others.

The pyrenae also are of two general shapes, one much deeper in proportion to the length than the other, and tapering more abruptly into the stipitate end. They are all straw-colored, woody, rounded and faintly keeled below, flattened to slightly convex above, with normally 4 longitudinal crests on the upper side, 2 central, and 2

which are the sides extended. Generally one or more of these crests, especially of the central pair, is more or less aborted. The keel is more prominent and laterally flattened at the distal end, and usually somewhat hooked at the tip. Pyrenae of the short, thick type range from 45 to 55 mm. in length, from 23 to 30 mm. in width, measured across the edges of the lateral crests, and from 15 to 18 mm. in depth, the perpendicular distance from the keel to the tops of the lateral crests, giving a length to width ratio of 1.94 : 1 and a length to depth ratio of 3.10 : 1. Pyrenae of the long, slender type vary from 55 to 65 mm. in length, from 22 to 30 mm. in width, and from 11 to 15 mm. in depth, a length to width ratio of 2.36 : 1 and a length to depth ratio of 4.90 : 1. Hillebrand gives no pyrena measurements, the figures in his specific description being the dimensions of the seed, but the drawing (reproduced as fig. 2), which is natural size, measures 52 mm. in length and 23 mm. in width, a ratio of 2.26 : 1. The depth is not shown, but the pyrena is evidently of the long slender type. The dorsal crests are extremely variable in height and degree of perforation, varying from mere ridges about 1 mm. in height to thin and lace-like wings 10 mm. high, or reduced to long slender filaments arising from a short triangular ridge. In general, the pyrenae from a given stand of trees are similar though not alike, but this is not definite (pls. 4, 5; figs. 2, 9, from the same tree; figs. 1, 7, may be from the same tree, certainly from the same grove; figs. 6, 10, 11, from the same grove).

Although the trees from the different localities on Oahu vary greatly in the shape of their leaves and of their pyrenae, there is no correlation between these leaf and pyrena shapes, and although at first glance it appears as though several species could be distinguished, and despite the tendency among systematists to accept seed and pit shapes as valid specific characters, the conclusion seems unavoidable that the Oahu *Pteralyxias* belong to a single polymorphic species. Several of the forms may possibly be worthy of varietal rank, especially that from Pupukea, which is extreme in several respects, but a recognition of that form as a variety would almost necessitate naming the trees of each grove as varietally distinct from the trees of every other grove, with possibly the occasional recognition of two or more varieties in the same grove. As this procedure would certainly serve no good purpose, but on the other hand would entail endless confusion, I shall refrain. I have no doubt, however, that

the trees from Kauai represent a distinct species, as the very small and abortive-crested pyrenae are far outside the range of variation as found on Oahu, and I am so recognizing it here.

The genus *Pteralyxia* is apparently of considerable antiquity, on Oahu at least, as the mould of a pyrena, undoubtedly referable to this genus and closely resembling the one shown in Schumann's drawing, was found in the ash thrown out by the eruption of Salt Lake crater, which filled the lower part of Moanalua Valley, at an elevation very little above sea level. It was associated with the fossilized remains of *Pritchardia* species, *Acacia koa*, *Metrosideros polymorpha*, *Dianella* species, and other present-day highland plants. The age of these ash beds has been variously estimated by geologists as between 50,000 and 150,000 years.

The Oahu material examined, in the herbaria of Bernice P. Bishop Museum (BPBM) and the Experiment Station, Hawaiian Sugar Planters' Association (HSPA) is as follows (The figures correspond with those on the map, fig. 1) :

WAIANAË MOUNTAINS

1. Makaha: leaves obovate, edges very slightly revolute; pyrenae short, thick, crests prominent; 2 sheets (Forbes), February 12-19, 1909 (BPBM).
2. Makua: leaves obovate, edges very slightly revolute; pyrenae short, thick, crests prominent; 1 sheet (Lyon), September 27, 1932 (HSPA).
3. Kanehoa Gulch: leaves obovate, edges slightly revolute; no fruits; 2 packages, unmounted (C. S. Judd 63), October 12, 1927 (BPBM).
4. Haleauau: leaves obovate to obovate-spatulate, edges very slightly revolute; pyrenae short and thick to long and slender, crests low; 4 sheets (Swezey), January 26, 1930 (HSPA), 4 sheets (Swezey), September 14, 1930 (HSPA), 1 sheet (Swezey), March 13, 1932 (HSPA).
5. Valleys below Puu Pane: leaves obovate, edges very slightly revolute; pyrenae short, thick, crests prominent; 1 sheet (Swezey), October 26, 1932 (HSPA), 1 sheet (Russ), December 27, 1932 (HSPA). This second collection is not from the same valley as the first one, but the plants are very similar.
6. Makaleha: leaves obovate to obovate-spatulate, edges revolute; no fruits; 1 sheet (Hillebrand, cotype), no date (BPBM), 3 sheets (Rock 17002), May 2, 1918 (BPBM).
7. Mokuleia: fruits only, pyrenae long, slender, crests medium; (Russ), March 15, 1932 (HSPA).
8. Kawaihapai: leaves obovate-spatulate, edges slightly revolute; pyrenae short, thick, crests prominent; 2 sheets (Russ, Moku. 8), March 25, 1932 (HSPA).
- Waianae, no definite location, probably from Makaha: leaves obovate-spatulate, edges slightly revolute; no mature fruits; 1 sheet (Faurie), May, 1910 (BPBM).

KOOLOU RANGE

9. Wahiawa Gulches: leaves obovate-spatulate, edges revolute; no mature fruits; 2 sheets (Forbes 1701 O), April 9, 1911 (BPBM).
10. Kaunala Valley: leaves obovate-spatulate, edges strongly revolute; no fruits; 3 sheets (C. S. Judd 12), January 16, 1925 (BPBM).
10. Pupukea: leaves obovate to obovate-spatulate, edges strongly revolute; pyrenae short, thick, crests very prominent; 7 sheets (Lyon 5010 L), March 14, 1924 (HSPA), 1 sheet (Hosaka), January 12, 1930 (BPBM), 1 sheet (St. John 10141), January 12, 1930 (BPBM), 2 sheets (Meebold), May, 1932 (BPBM). These four collections are all from the same grove of trees.
11. Laie: I have seen no specimens from this locality, although trees are known there.
12. Kaaawa: leaves obovate-spatulate, edges revolute; no fruits; 2 sheets (Forbes 1396 O), May 30, 1909 (BPBM).
13. Kalihi: leaves obovate, edges very slightly revolute; no fruits; 2 sheets (C. S. Judd), May 13, 1932 (HSPA).
14. Nuuanu: leaves obovate, edges very slightly revolute; no fruits; 2 sheets (Hillebrand, cotype and part of type), no date (BPBM).
15. Waialae-iki: leaves obovate-spatulate, edges very slightly revolute; pyrenae long, slender, crests prominent; 5 sheets (Lyon and Duvel D-33), January 2, 1925 (HSPA), 2 sheets (Ewart and A. F. Judd 27), October 24, 1929 (BPBM). Both these collections are from the same grove of trees.
16. Wailupe: leaves obovate-spatulate, edges slightly revolute; pyrenae long, slender, crests prominent; 2 sheets (Garber and Forbes 183), January 12, 1920 (BPBM).
17. Waimea: leaves obovate-spatulate, edges strongly revolute; no mature fruits; 1 sheet (Forbes 2038 O), February 10-13, 1915 (BPBM). This seems to be the same as the Pupukea-Kaunala form.

UNLABELED

- Probably from Makua, Waianae range: leaves obovate, edges very slightly revolute; no fruits; 1 sheet (Forbes), no date (BPBM).
- Probably from Makaleha, Waianae range: compares well with, and is probably a part of, Rock 17002 (BPBM).
- Probably from Wailupe, Koolau range: probably a part of the Garber and Forbes collection, number 183 referred to above (BPBM).

***Pteralyxia kauaiensis*, new species.**

Arbor, ad 8 m. alta; folia obovata-spatulata, coriacea, 25 cm. longa, 8 cm. lata, basi cuneata, apici rotundata aut obtusa, marginibus paulula revoluta, costa subter prominens, supra canaliculata, nervi laterali paulo prominenti; petioli 2 ad 2.5 cm. longi; fructi rubens, ovoidei, punctati, 46 x 16 mm.; pyrenae lignosae, una vel ambo alae laterales abortivae, alae mediae latae separatae, 2.5 ad 3 mm. altae, ad ultima pars perforatae, carina prominens et ad ultima pars aduncta; flores non visi.

A gnarled, twisted tree about 25 feet tall; leaves coriaceous, obovate-spatulate, to about 25 cm. long by 8 cm. wide, rounded or very bluntly pointed at the apex, cuneate at the base, the margins very little revolute, the midrib

prominent beneath, channeled above, the veins little prominent; petioles 2 to 2.5 cm. long; drupes red, ovoid, punctate, 46 mm. long by 16 mm. in diameter; pyrenae woody, straw-colored, 45 x 15 mm., one or both of the lateral crests generally aborted, the central crests widely separated, 2.5 to 3 mm. high, somewhat perforated at the tips, the keel prominent and hooked at the distal end; flowers not seen.

The Kauai species here described as new is known thus far from only one general locality. Further exploration may show it to be as widely distributed on its own island and as variable as its Oahu congener. The description here given may on that account be subject to later emendation, though it is based on rather full material, barring flowers, which were not present on any of the specimens at hand.

The trees were found at Haupu, Kauai, and recognized as a peculiar *Pteralyxia* by Mr. Albert W. Duvel, and later, on December 17, 1925, specimens from them were collected by Mr. Duvel and Dr. H. L. Lyon, and on March 4, 1927, by Mr. Duvel and Dr. L. H. McDaniels. One sheet, without flowers or fruits, in the Bernice P. Bishop Museum herbarium (Forbes 615 K), collected somewhere in the Hii Mountains on October 20, 1916, undoubtedly represents this same species.

The species differs from *P. macrocarpa* in its various forms principally in the pyrenae, which are much smaller and more spindle-shaped, with crests much less conspicuous than in any except the Haleauau form of *P. macrocarpa*. In general, only the central pair of crests are at all conspicuous, the lateral pair being entirely aborted or represented by slight ridges only. In *Pteralyxia macrocarpa*, on the contrary, any reduction affects primarily the central pair, secondarily the lateral pair of crests.

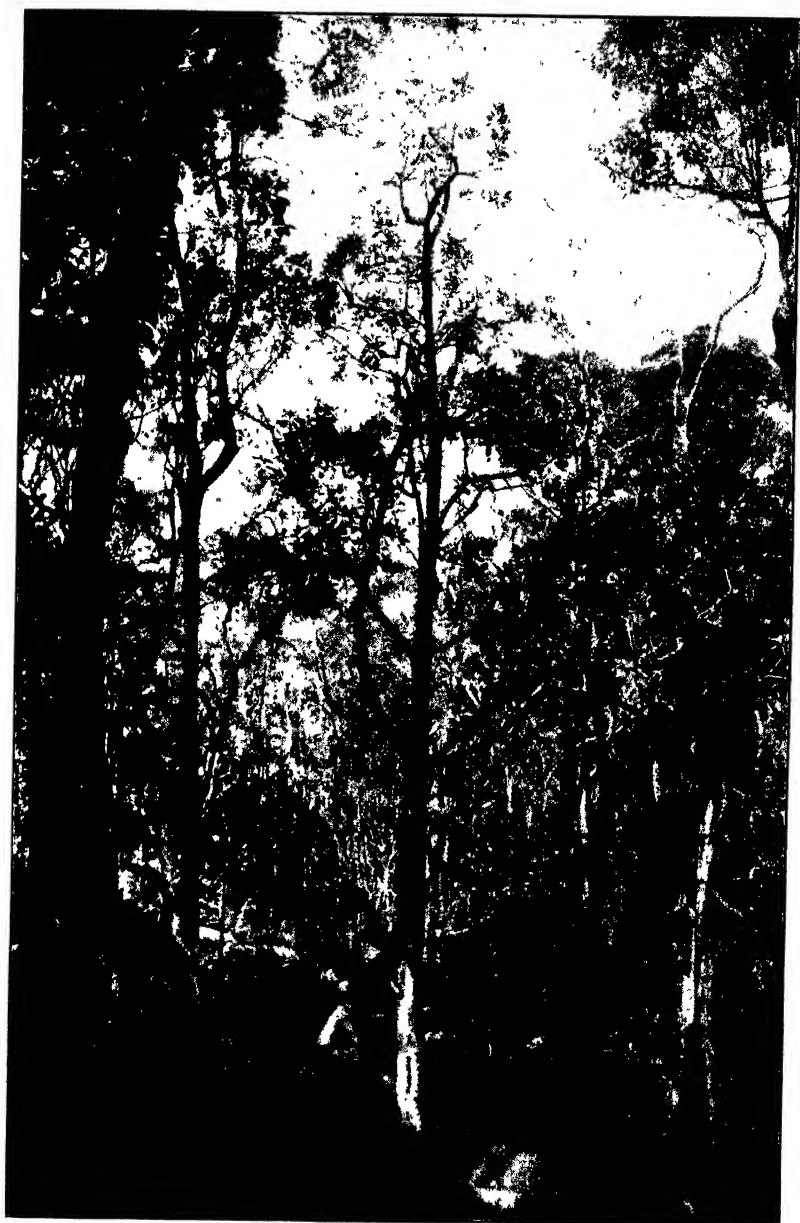


PLATE 1.—*Pteralyxia macrocarpa* on Pupukea-Malaekahana trail.

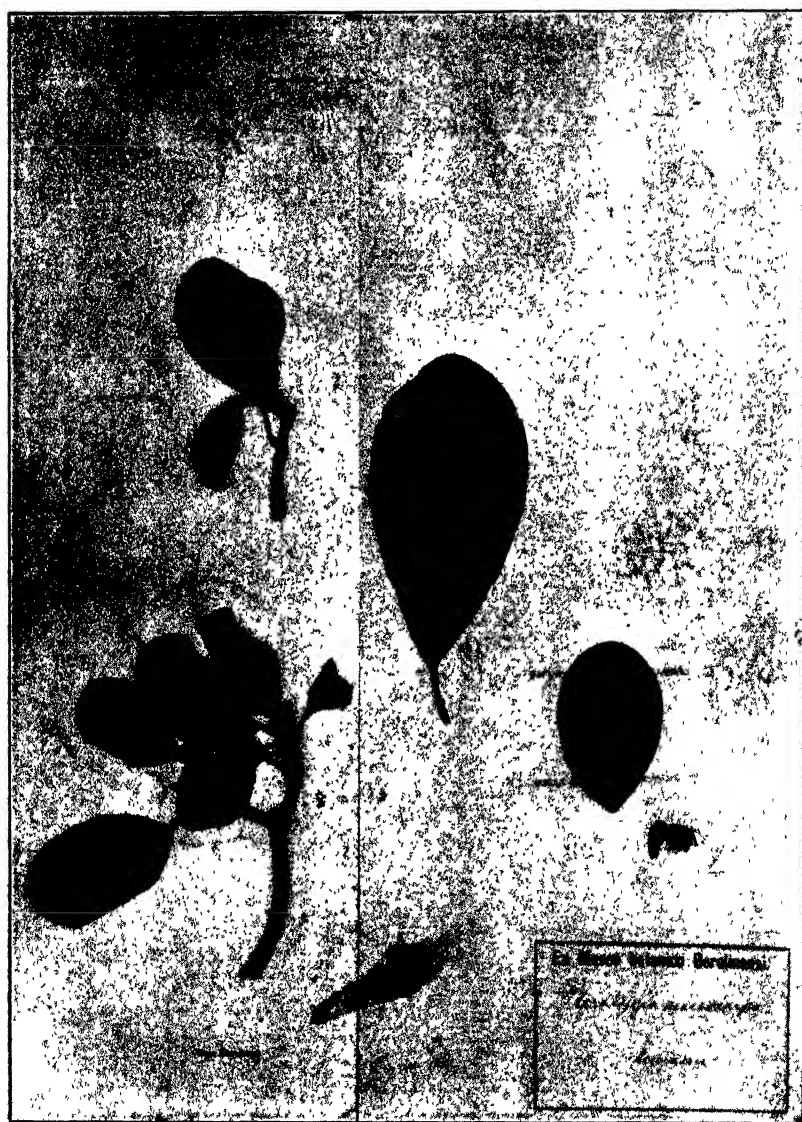


PLATE 2.—*Maculixia macrocarpa* from Nuuanu: left, cotype; right, part of type, \times about $1/3$.



PLATE 3.—*Pteralyxia macrocarpa* from Makaleha: cotype, \times about $1/3$.

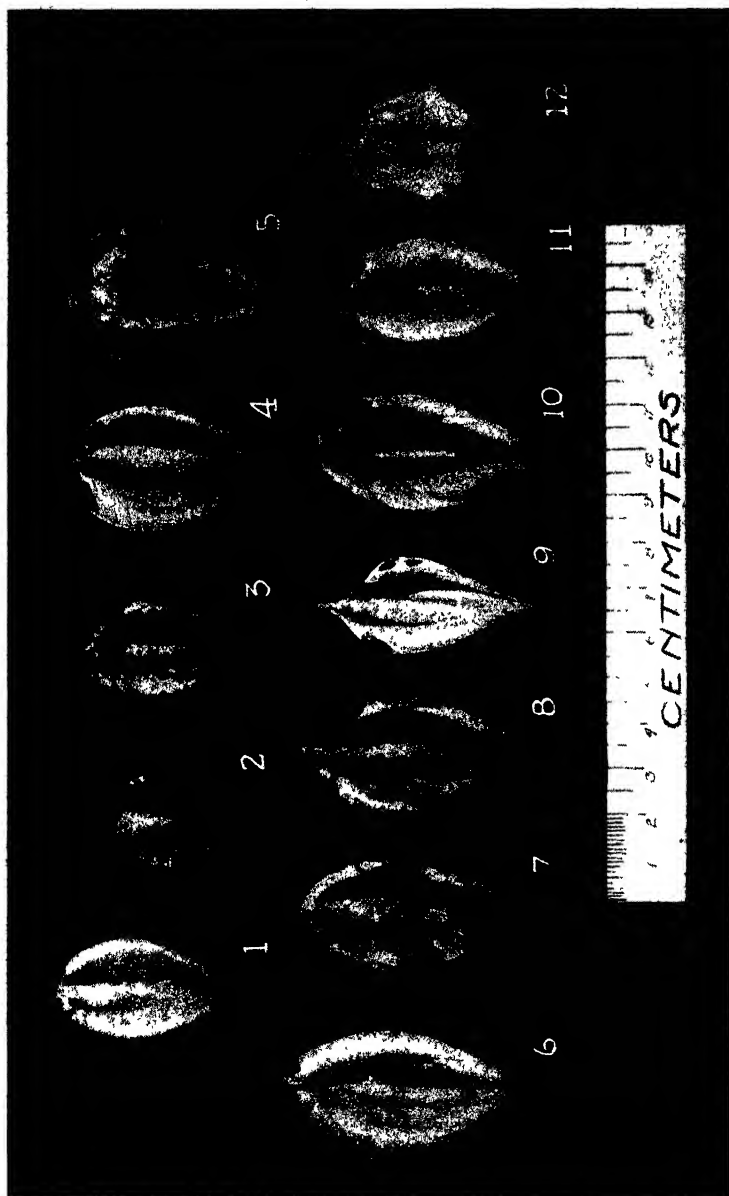


PLATE 4.—Pyrenae of *Pteralyxia macrocarpa*: 1, Haleauau; 2, Puu Pane; 3, Makua; 4, Kawaihapai; 5, Pukea; 6, Waialae-iki; 7, Haleauau; 8, Mokuleia; 9, Puu Pane; 10, Waialae-iki; 11, Waialae-iki; 12, Wailupe. (See fig. 2).

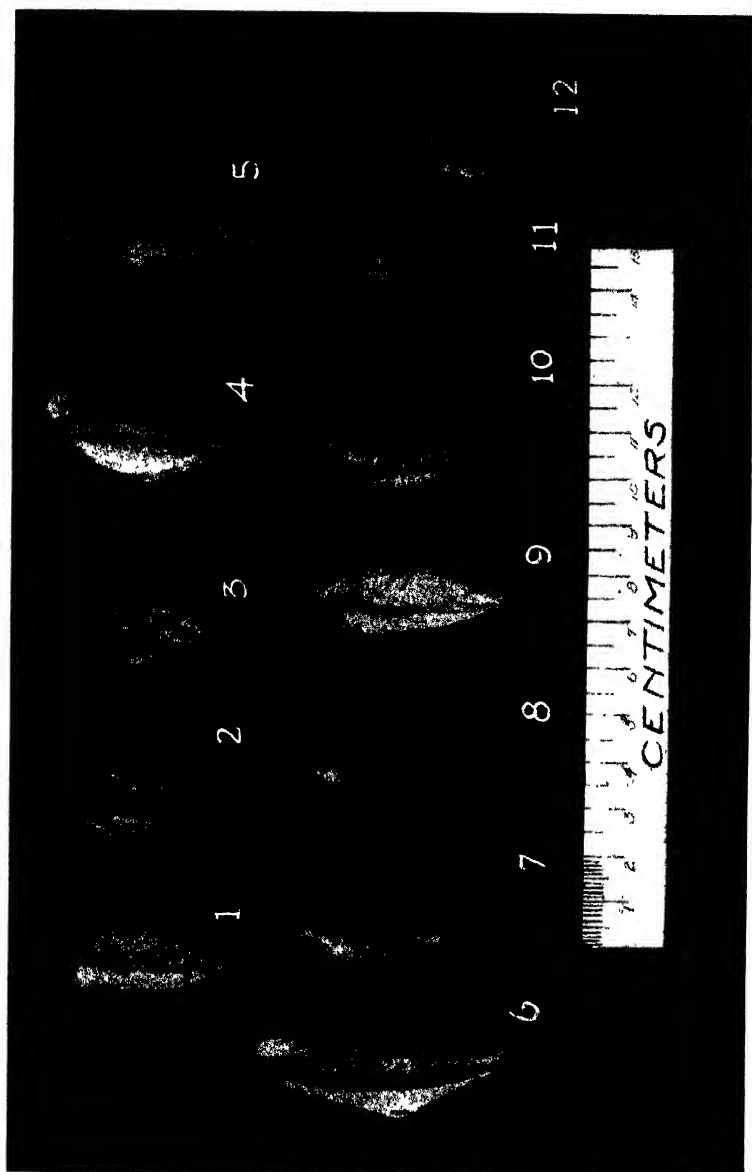


PLATE 5.—Pyrenae of *Pteralyxia macrocarpa*. Localities numbered as in plate 4.

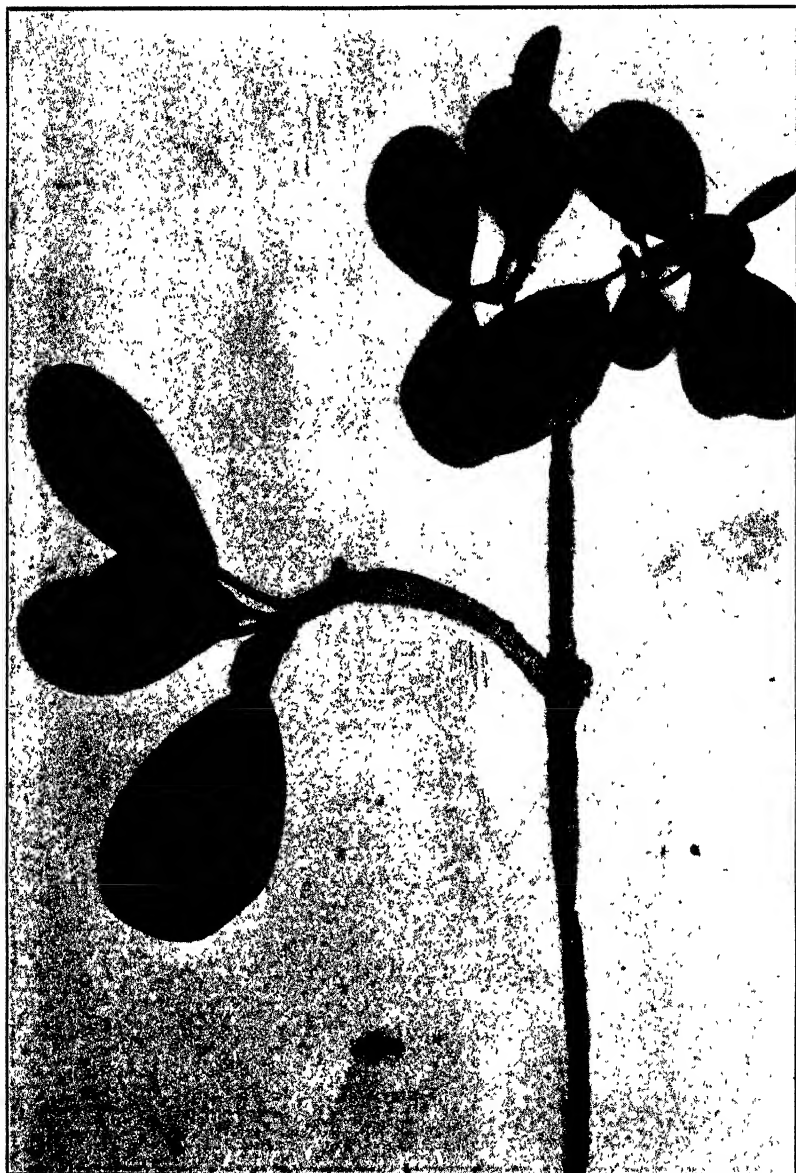
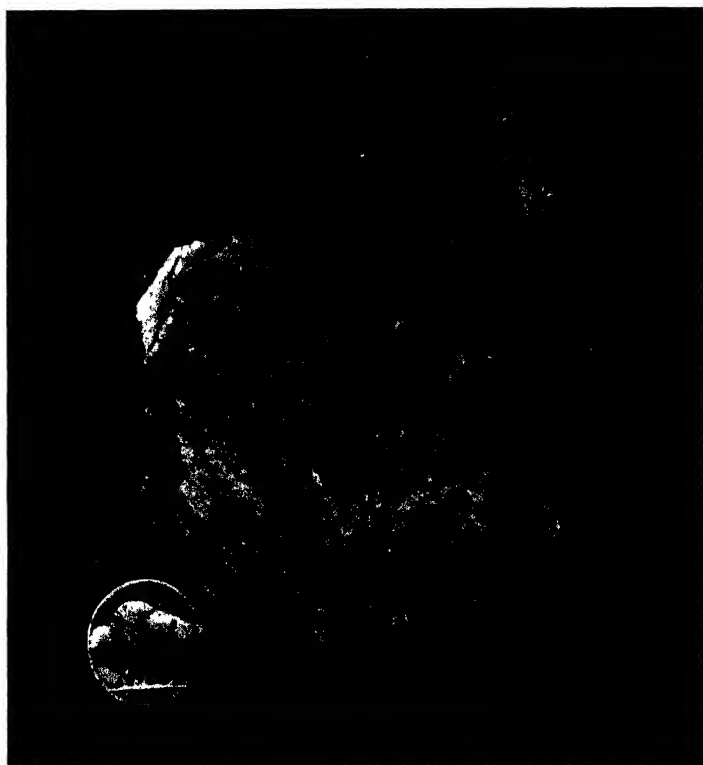


PLATE 6.—*Pteralyxia macrocarpa*: a fruiting branch of the Pupukea form.



A



B

PLATE 7.—A, Fruits of *Pteralyxia macrocarpa*: 1, Makua; 2, Puu Pane.
B, Mould of a pyrena of *Pteralyxia* from the Salt Lake ash.

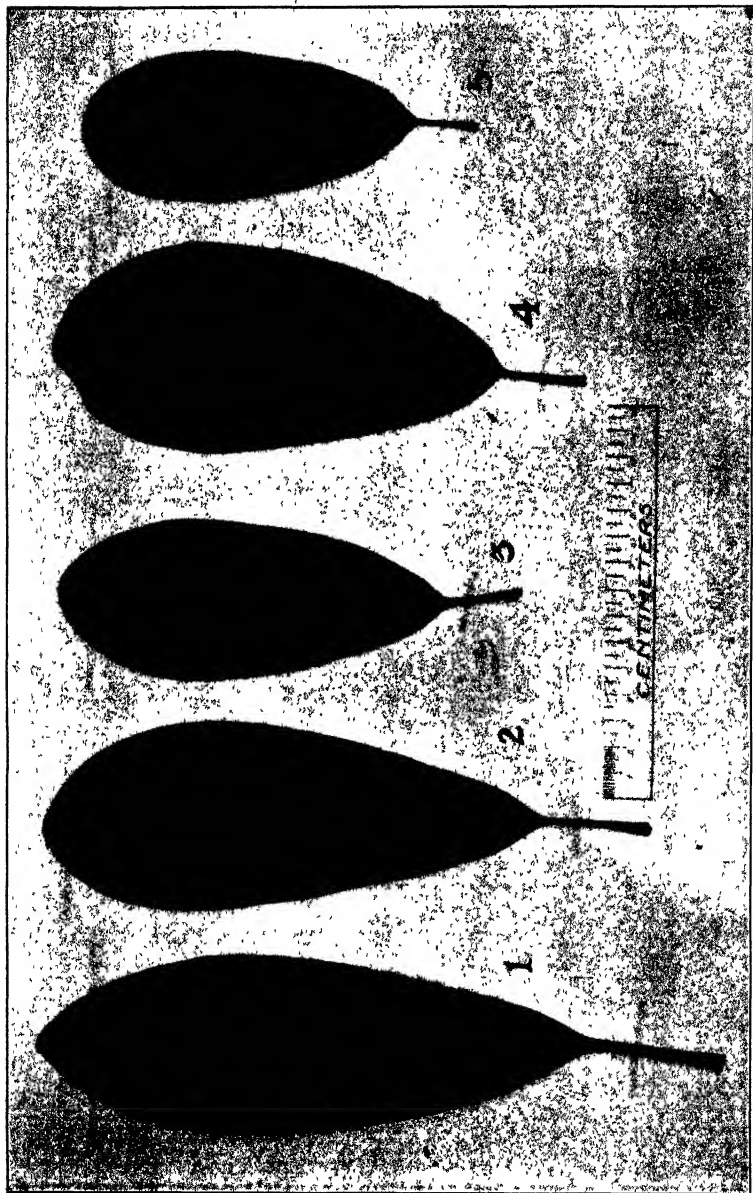


PLATE 8.—Leaves of *Pteridylxia macrocarpa*, upper surface: 1, Pupukea; 2, Waialeale-iki; 3, Kaaawa; 4, Haleauau; 5, Wailupe.

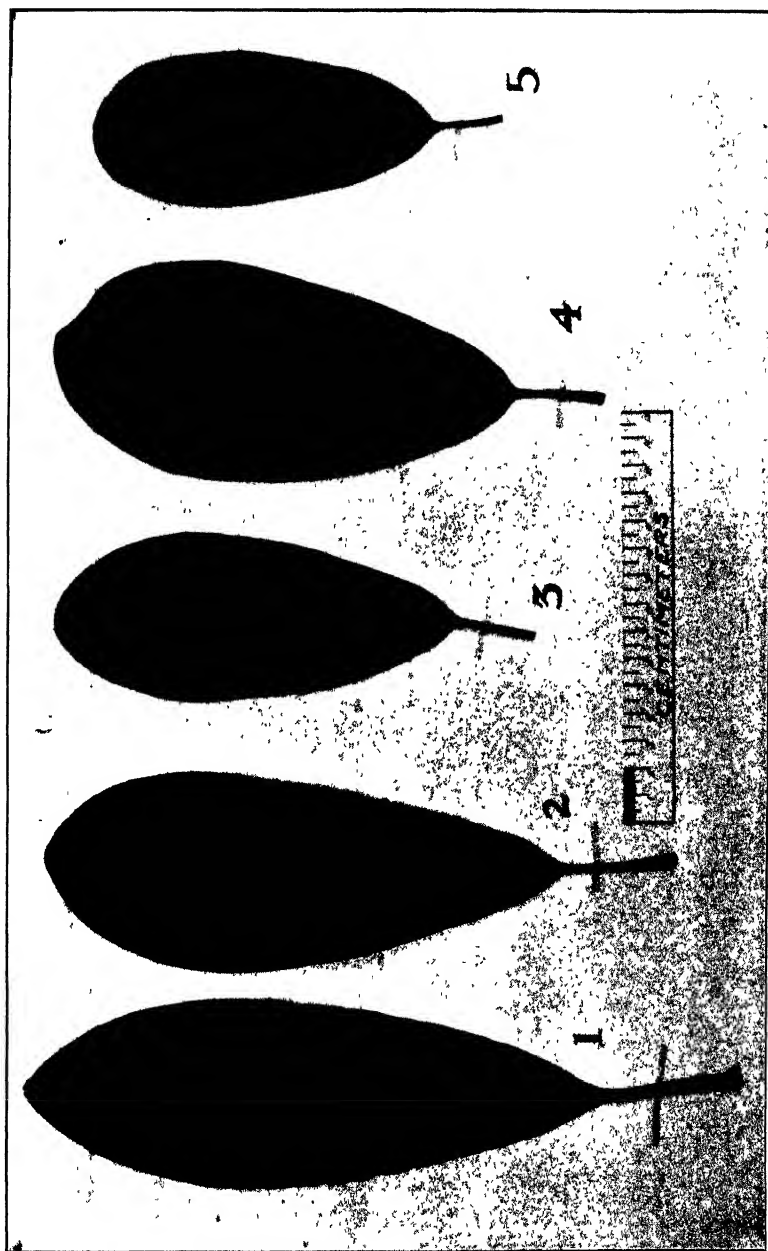


PLATE 9.—Leaves of *Pteralyxia macrocarpa*, lower surface. Localities numbered as in plate 8.

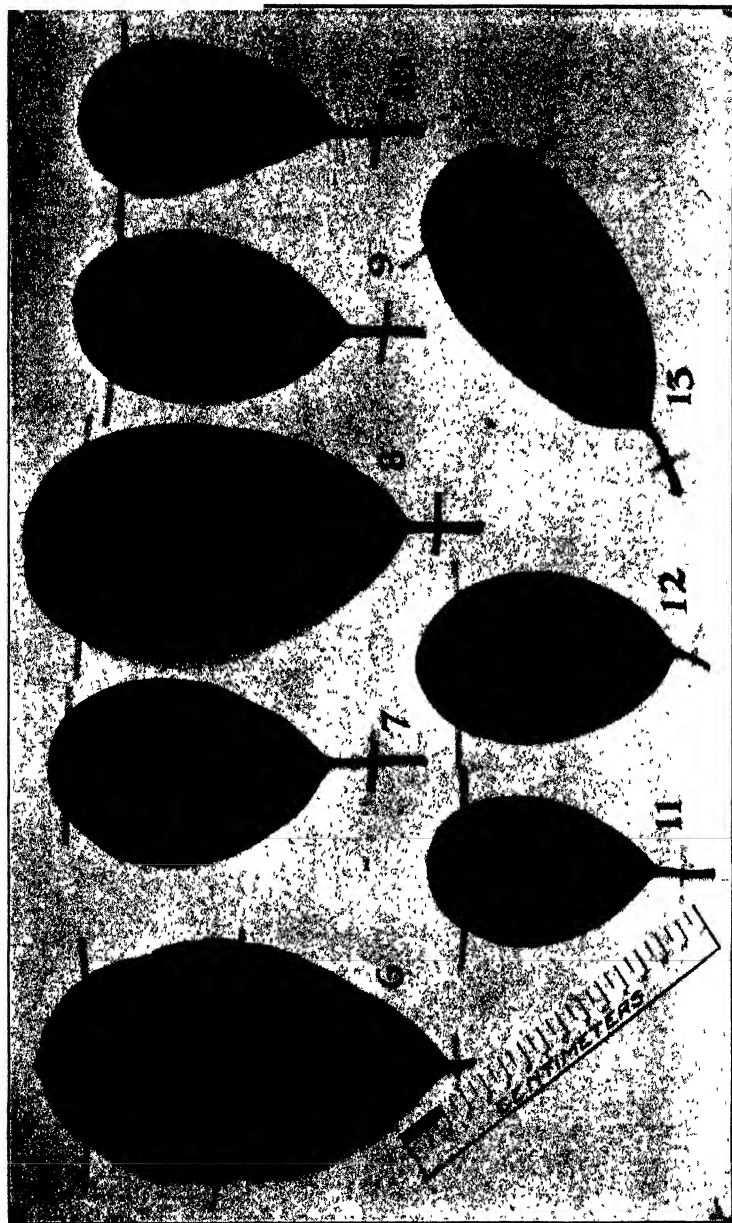


PLATE 10.—Leaves of *Pteralyxia macrocarpa*, upper surface: 6, Kanehoa; 7, Makaleha (compare pl. 3); 8, Puu Pane; 9, Mokuleia; 10, Wahiawa gulches; 11, Kalihi (compare pl. 2); 12, Haleauau (compare pl. 8, fig. 4); 13, Pupukea (compare pl. 8, fig. 1; pl. 6).

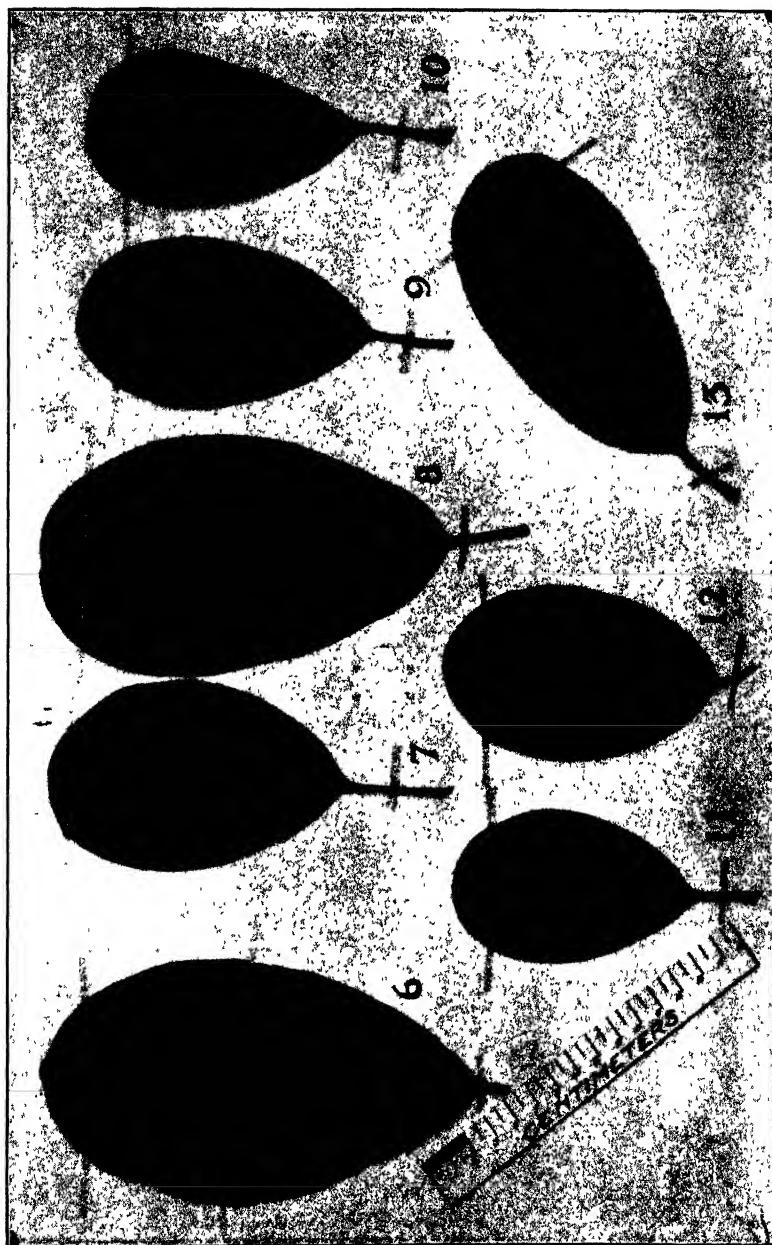


PLATE 11.—Leaves of *Pteralyxia macrocarpa*, lower surface. Localities numbered as in plate 10.



PLATE 12.—*Pteralyxia kauaiensis*, new species.

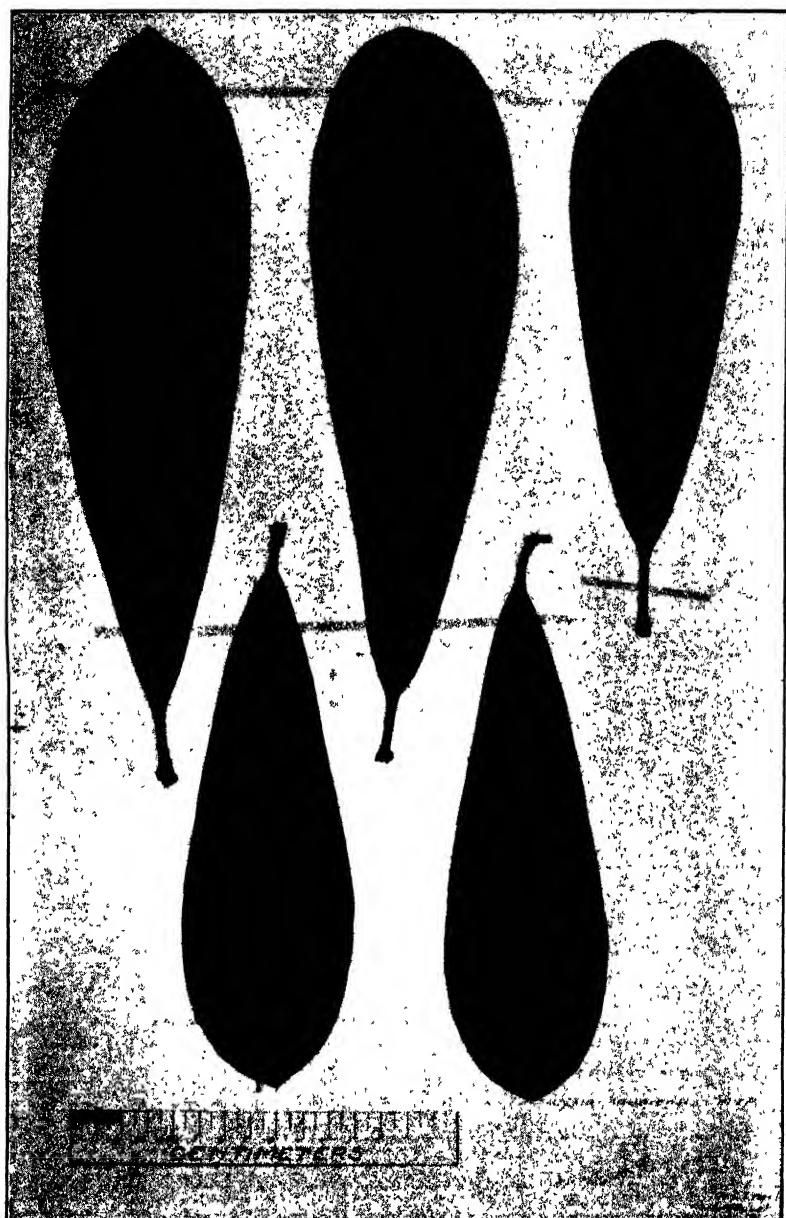


PLATE 13.—Leaves of *Pteralyxia kauaiensis*, new species.

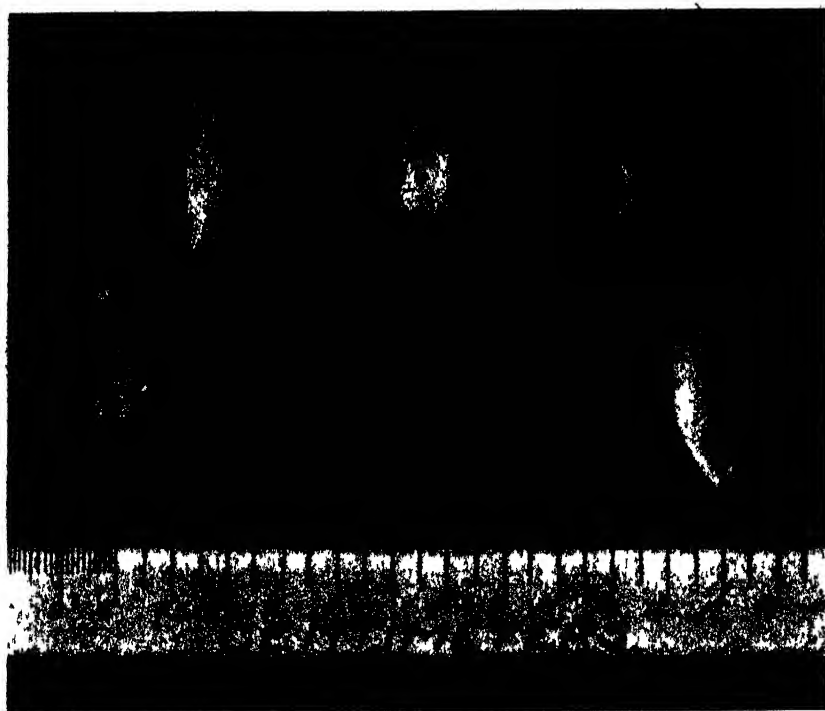


PLATE 14.—Pyrenae of *Pteralyxia kauaiensis*, new species.

THE EXOTIC BIRDS OF HAWAII

By

EDWARD L. CAUM

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THE EXOTIC BIRDS OF HAWAII

By EDWARD L. CAUM

INTRODUCTION

Many times has the statement been made that the bird life of Hawaii appears to consist almost exclusively of the mynah, the sparrow, and the dove. The series of notes here presented is prepared in an attempt to refute this statement. The birds considered are only those not native to Hawaii; the endemic and indigenous species have been thoroughly treated in such classical works as Rothschild's "Avifauna of Laysan and the neighboring islands," and Wilson and Evans' "Aves Hawaiienses," and more briefly by Perkins in the "Fauna Hawaiiensis," by Henshaw in his "Birds of the Hawaiian islands," and by W. A. Bryan in "A key to the birds of the Hawaiian islands" and "The natural history of Hawaii."

Foreign birds have been introduced and liberated in Hawaii from very early times; one species—the domestic fowl, now feral—is of aboriginal introduction. The majority of the foreign birds, however, have been liberated comparatively recently. For the purpose of the discussion, these birds may be roughly classed into two main groups, the game birds, imported and liberated with official sanction for the benefit of sportsmen, and the non-game birds, some of which were imported for economic purposes, some brought in as cage birds and liberated by their owners, and some accidental escapes from captivity. In number of species the game birds form by far the larger group, but it is exceeded in number of individuals by the non-game birds group. No attempt has been made to include in this list those birds which are known to occur or to have occurred here as casuals or strays, or which are regular migrants, or species which are known only in domestication or as cage birds. Those species only are included whose presence in the wild state is or was due to human efforts.

It has been only within the past few years that any definite records of bird introduction have been kept, and many of these are not entirely comprehensive. For instance, it is recorded that on March 5, 1921, there were imported from the Orient for Maui County 28 pheasants, 502 doves, and 3 partridges, and on June 5 of

the same year 75 pigeons, 100 doves, and 100 quail, with no notation as to species or kinds. A record like this does not greatly help in a tabulation of species, and there are many reports no more definite. This is unfortunate, but where game birds were concerned such records have fulfilled the official requirements. If the particular varieties in the shipment were not specified in the accompanying papers, it was not necessary to investigate further. Of course, as there was with the non-game species the possibility that birds inimical to agriculture might be offered for introduction, species not obviously belonging in the game bird category have been closely scrutinized, within the past 15 years or so at least, and only those admitted whose potentialities for evil seemed slight.

Early records are extremely fragmentary and scattered, and many contain no definite notation as to when a given species made its appearance in Hawaii. As early as 1855 Mr. J. W. Marsh, in an address given at the Fifth Annual Meeting of the Royal Hawaiian Agricultural Society, said that "a record of the introduction of new species [of birds] is still a desideratum." Note the word "still." His statement holds good today; after almost 80 years such a record is still a desideratum. Had it not been so at that time and for many years thereafter, the task of compiling the present data would have been considerably simplified. Unfortunately, Mr. Marsh neglected to mention any of the species he had in mind, but from contemporary newspaper accounts it is known that during the time of the Royal Hawaiian Agricultural Society, 1850 to 1867, enthusiasm for bird introduction was great. To quote from *The Polynesian* of October 22, 1853:

Mr. Taner brought from Australia an Australian Ostrich or Emu, a pair of Black Swans, a Kangaroo Rat and a pair of White Rabbits, as well as a variety of plants and shrubs, some of which are new at the Islands. The introduction of new animals, plants &c., by residents returning from their visits to other countries, is highly praise-worthy and commendable; and we hope persons visiting foreign countries and returning, will bear in mind that they may thus contribute to the general good of the islands, by the introduction of many things that will contribute to the pleasure or profit of themselves or the residents generally.

The Commercial Advertiser of August 16, 1860, has this to say apropos of the importation of 15 pairs of goldfinches and chaffinches from Germany: "Owners of vessels leaving foreign ports for Honolulu, will confer a great favor by sending out birds, when it

can be done without great expense. We need more songsters here." According to the same paper, a further shipment of two green linnets, three goldfinches, two chaffinches, and one thrush was received from Germany by H. Hackfeld & Co. and delivered to the Royal Hawaiian Agricultural Society. The Hawaiian Gazette states that in 1866 Dr. William Hillebrand brought, with a shipment of plants from Asia, carrion crows from Calcutta, two species of goldfinches, Indian sparrows, Japanese finches, Chinese quail, silver, Mongolian, and golden pheasants, linnets, ricebirds, and mynahs.

We know of these importations only from the newspaper accounts, and, as may be seen, many of the particular species involved are not certainly known. It is extremely unfortunate that the records of the Royal Hawaiian Agricultural Society for this period are lost, as it is not improbable that the minutes of the Society would go into greater detail concerning the birds imported and liberated under its auspices. The minute books of the Society for the years 1857 to 1866 are apparently gone forever. The species mentioned above, with very few exceptions, have almost certainly not survived in the Territory to the present time. Those whose specific identification is doubtful have been omitted from the list in this paper.

Most of the early references to foreign birds are casual, and many are contradictory; we can do no more than to accept as true the ones that seem most reasonable. Even within the past few years many birds have been liberated by private individuals. Of such introductions there are naturally no official records or, for that matter, records of any kind. Here we must depend upon bird lovers for the necessary information. Even more must we depend upon them for information as to the establishment of a species. Birds of many kinds have been liberated and never seen again, but it should not be stated categorically that such birds are not present in Hawaii. The supposition is that the species has failed to persist, though in the final analysis it simply means that the birds have not been seen by a qualified observer whose testimony is available. The list given in this paper therefore includes all the species, with the exception of those noted in the paragraph above, of which any record has been found to show that the bird was at one time present in the wild state or was released with the idea that it might propagate and establish its species. A description of each species, brief but adequate for identification, has been included. It may be that through such descrip-

tions there will be brought to light reports of the continued existence in Hawaii of species now thought to have died out.

A record of the sort here presented should be of value, particularly at the present time, as since the organization of the Hui Manu in 1930 there has been a great increase in public interest in bird introduction, and appreciable sums of money have been contributed by this organization as well as by private individuals toward the purchase of song and insectivorous birds for liberation in the islands. If there is to be a systematic or even a semi-systematic program of bird introduction into Hawaii, there should be made available a knowledge of the species already introduced, to the end that persons interested may know what birds have been introduced with success, and which attempts have been followed by failure. Credit for the establishment of a species may then be laid at the proper door. Likewise, disappointment may be avoided in the attempted reintroduction of a species that has repeatedly failed of establishment in the past. Again, numerous notices to the effect that such-and-such a bird would be a wonderful addition to the island avifauna and should be introduced, or that so-and-so has just imported the first representatives of a species to be brought to Hawaii appear in the press. Some of these statements, more particularly the second, are correct, but most of them are not, for buried somewhere in a mass of miscellaneous notes may very probably be found a statement that this "new" species was brought here 50 or 60 years ago and failed of establishment; it may even be present in the Territory, although sparsely distributed. A knowledge of early introductions should be of use as well as of interest, and to that end I have attempted to compile and correlate such data as are available on the subject.

The advisability of the introduction of any foreign bird, with the possible exception of the game birds, into a new country is decidedly a moot point, and there are in the United States several schools of thought on the subject. One, led by a number of conservative naturalists and ornithologists, would bar all foreign birds, to preserve at all cost the original, or rather the present, status of the native species, pointing out the great amount of damage that has been done in various parts of the world by the promiscuous introduction of foreign birds, and especially the danger of spreading avian diseases. Another group would bring in anything "from a humming bird to an

ostrich," regardless of its general suitability. It will be found that the majority of persons who have given thought to the problem will sympathize more strongly with the first group, but will endeavor to find a happy medium. There is undoubtedly a great deal to be said in favor of stringent restrictions in any program of bird introduction, and as a general rule a complete ban is likely to be of greater benefit to the country in the end than is no control at all. However, it does seem that a controlled and restricted program, with a careful selection of candidates for liberation, would be attended with but little potential danger, especially in a country like Hawaii where the native birds still in existence are very rare and restricted to the deep forests and accordingly would not come into competition with any imported species inhabiting the lowlands.

The whole question of bird importation is highly controversial, and a more detailed discussion of the arguments pro and con is outside the scope of this paper. Several references to published articles dealing with this phase of the subject are included in the bibliography. Suffice it to say that the experience of Hawaii has been far different from and far happier than that of New Zealand, for example. In Hawaii only one bird can really be classed as economically detrimental, the ricebird, and even this species has something to be said in its favor. There is a very widespread impression that the mynah is a pest. It may be accepted as true that the mynah is a nuisance, but it is not a pest. It did and is continuing to do an immense amount of damage in the spread of such plant pests as the *Lantana* and the *Melastoma*, but it also did and is continuing to do an immense amount of good in the destruction of such insect pests as the cutworms and army worms. In New Zealand, on the other hand, the skylark is exceeded in destructiveness only by the English sparrow, and many other birds could very well be spared. In Hawaii the English sparrow is at worst economically negligible, and he who would advocate the extermination of the skylark in these islands would be a brave man indeed.

The publications listed in the bibliography (p. 52) are those in which information may be found on the birds in their relation to their native lands, to Hawaii, or to other countries into which they have been introduced, or in which technical information is contained. The list does not pretend to be complete, but contains simply the best of the literature that I have had occasion to consult. Much of the

information in this paper was not culled from books, however, and in this connection I must express my appreciation for the very valuable aid given me by persons whose interest in the bird question in Hawaii is great, and particularly to Mrs. Dora R. Isenberg and Mr. H. D. Sloggett of Kauai, Mr. G. C. Munro of Lanai, Mr. James Munro of Molokai, Mr. D. T. Fleming of Maui, and Mr. L. W. Bryan of Hawaii, who have given me data on the present status of the exotic birds on their respective islands, to Mr. Joseph Tavares of the Fish and Game Commission for further information concerning the game birds in particular, and to Mr. L. A. Whitney of the Territorial Division of Plant Inspection, through whose hands all wild birds imported into Hawaii must pass, and who has given me free access to the records of his office. Thanks are due also to Dr. Alexander Wetmore of the Smithsonian Institution of Washington and to Dr. Herbert Friedman of the United States National Museum, who have kindly checked over the technical names and made the revisions necessary to bring them up to date, and who have supplied items of information not accessible in the literature at hand.

References are made in the text by means of an asterisk preceding the scientific name to specimens examined in the Bernice P. Bishop Museum collections.

The systematic arrangement of the orders and families follows that proposed by Dr. Wetmore, "A systematic classification for the birds of the world," in the Proceedings of the United States National Museum, volume 76, 1930. The listing of the genera and species is alphabetical.

For the sake of completeness, and to make possible a wider dissemination of the information, abstracts of the Territorial statutes relating to birds are appended (p. 51).

ORDER PELECANIFORMES

Family PHALACROCORACIDAE—Cormorants and Shags

Phalacrocorax carbo (Linnaeus).

Cormorant

A long-necked pelican-like bird, about 36 inches long. General color black glossed with iridescent dull purplish and bluish green; a well-developed crest extending on to the nape; upper back, shoulders, and wings dull bronze brown, each feather widely bordered with dark bluish green; in breeding plumage the top of the head and the greater part of the neck covered with long narrow white feathers, and a large white patch on each flank; eye bright green, naked

skin around the eye greenish brown, below the eye and the gular sac lemon yellow; bill long, hooked, gray brown, yellowish white toward the base; legs and feet blackish.

Distribution almost world-wide, principally along seacoasts. Mr. George Munro reports that sometime in the nineties Mr. Francis Gay liberated several Chinese fishing cormorants on Lanai, but they apparently did not survive.

ORDER CICONIIFORMES

Family PHOENICOPTERIDAE—Flamingos

Phoenicopterus ruber (Linnaeus).

Flamingo

A long-legged and long-necked bird, standing about 5 feet tall. Prevalingly light vermilion all over, the wing coverts brighter; bill heavy and unwieldy-looking, high at the base and abruptly bent down in the middle, yellowish, black at the tip; feet red.

A native of southern Florida and the West Indies, inhabiting the shallow lagoons and feeding on mollusks. Three individuals were brought from Cuba in 1929 by Mr. H. D. Sloggett and set free on his property on Kauai. They did not survive more than a year or so.

ORDER ANSERIFORMES

Family ANATIDAE—Ducks, Geese, and Swans

Anas platyrhynchos Linnaeus.

Mallard Duck

Length, male $23\frac{1}{2}$ to $25\frac{1}{2}$ inches, the female somewhat smaller. Male: head and neck brilliant metallic green, the crown and forehead overlaid with black; a narrow white ring around the lower neck immediately below the green, interrupted behind; between the shoulders brownish gray with paler feather edgings; sides of back silvery white minutely barred with dusky; back, rump, and upper tail coverts black with steely blue reflections; tail feathers mostly white with the two middle feathers black and slightly curled upwards, and the two longest tail coverts conspicuously curled upwards; wings brownish gray with metallic violet near the lower edge, bordered in front and behind with black and white feathers forming a black and white bar at both margins; breast dark chestnut; sides and rest of under surface silvery gray undulated, with dusky; under tail coverts black; bill greenish yellow; feet orange red. Female: head and whole upper surface chiefly deep brown, variegated with abruptly paler feather edgings; general tone of head paler, with a finer, more streaky pattern than on the back; top of head darkest, sides of head lighter with a dusky streak through the eye; throat very light brownish, scantily or not at all streaked; wings much as in the male; ground color of under surface brownish white, but the black-centered feathers give a streaked or mottled appearance.

The species is native to the Northern Hemisphere generally, and migratory or casual as far south as Bermuda, Panama, and Hawaii. The food is primarily vegetable, principally aquatic plants. Fish, small mollusks, crustaceans, and worms are also taken, although animal matter forms a small part of the diet. The species has been introduced into Hawaii at different times but has not become established in the wild. Probably the birds joined migrations, as it is known that migrating individuals of this species occasionally pass through Hawaii. Some birds live in a semi-domesticated to entirely domesticated state in several places on Hawaii, as Keeau and Puu Oo.

Chenonetta jubata (Latham).

Maned Goose

Length about 20 inches. Male: crown deep brown; tail and lower back black; short black plumes on the nape; breast gray spotted with black; upper part of wing gray-brown, lower part metallic green and white; bill olive brown. Female: smaller and duller in color than the male, the breast spotted with white.

A native of Australia and Tasmania, where it is very common near water, feeding on grass, snails, and insects. A few individuals were imported from Australia in 1922 by the City and County of Honolulu and liberated on Oahu. They did not survive.

Querquedula discors (Linnaeus).

Blue-winged Teal

Length 15 to 16 inches. Male: head and neck deep gray with purplish reflections; crown black, a broad white crescent bordered with black across the front of the head; breast and under parts pale reddish buff spotted with dusky gray on the breast and barred on the flanks; back reddish brown, marked with black and buff crescents, more greenish near the tail; shoulders dull sky blue; wing patch green bordered with white; bill grayish black; feet yellowish. Female: dusky brown marked with buff; an indistinct white patch on the chin; sides of neck and head whitish, finely marked with black spots except on the throat; breast and under parts paler than in the male; wings similar but with less white.

The species ranges over most of North and South America. The birds are primarily vegetarians, feeding on aquatic plants, and will go into the brush for seeds and succulent bits. Worms, small crustaceans, mollusks, and fish are also taken. Birds of this species are said to have been imported from Australia in 1922 by the City and County of Honolulu. They did not survive.

Sthenelides olor (Gmelin).

Mute Swan

Length $4\frac{1}{2}$ to 5 feet. Sexes similar, the female somewhat smaller and more slender than the male. Entire plumage pure white; an area behind the

eye, the frontal tubercle, the base and edges of the upper mandible, the nostrils, and the entire lower mandible black, rest of upper mandible orange; legs and feet dull black.

A native of Europe and northern Asia, and a favorite ornament of large estates and public parks. A few birds were imported by Mr. W. S. Wise of Hilo about 1920 and liberated on the Wailua River. A small colony is maintaining itself there, a short distance above Hilo, without outside assistance.

ORDER FALCONIFORMES

Family FALCONIDAE—Falcons

Falco species.

Falcon

A pair of birds, tentatively identified by Mr. L. W. Bryan as the gyrfalcon (*F. rusticolus*), escaped from the Japanese naval tanker *Sato* in May, 1929. They had been obtained in Vancouver, B. C., and were being taken to Japan, but, probably through the carelessness of an attendant, they made good their escape while the ship lay in Hilo harbor. One of the birds was captured and killed a short time later; the other at last reports was still at liberty somewhere in the neighborhood of Hualalai. It is fortunate that both birds did not escape completely.

ORDER GALLIFORMES

Family CRACIDAE—Curassows, Chacalacas, and Guans

Crax globicigera Linnaeus.

Curassow

A heavy turkey-like bird, about 34 inches long, the tail 13 inches. Male: plumage black glossed with dark green; a conspicuous crest, the feathers curled at the tips; middle abdomen and flanks white; bill blackish, the base and wattle yellow. Female: crest black with a band of white; sides of head and neck barred with black and white; remainder of upper plumage chestnut; abdomen marbled black and buff; tail barred black and buff; bill grayish green, yellow at the tip.

A native of the deep forests of Panama, feeding on both animal and vegetable matter. An excellent game bird. Two pairs were imported from Panama in 1928 by Hawaii County and there liberated. The birds are seen occasionally, but are not known to be breeding.

Ortalis cinereiceps cinereiceps (Gray).

Chacalaca

A slender pheasant-like bird, the sexes alike. Length 22 inches, the tail 9½ inches. Top of head and nape dark gray; remaining upper plumage grayish brown; tail darker brown, broadly tipped with grayish buff; longer wing quills bright chestnut; breast grayish brown, shading on the remaining under parts to grayish buff; throat almost naked; bill short, horn-colored.

A native of Panama, inhabiting partly open places as well as the deep forests, living in trees and feeding on animal and vegetable matter. Another excellent game bird. Two pairs were imported from Panama in 1928 by Hawaii County. They are not known to be breeding, although they still persist.

Penelope cristata cristata (Linnaeus).

Guan

A chicken-like bird, the sexes alike. Length 35 inches, the tail 14 inches. Plumage olive above, glossed with coppery green, the conspicuous crest darker; lower back and rump changing to dull chestnut; crest and breast dull olive streaked with fine white lines; abdomen dull chestnut; tail dull chestnut glossed with coppery green; throat naked, the skin dull carmine; feet coral red.

A native of the heavy forests of Panama, feeding on both animal and vegetable matter. A valuable game bird. Three pairs were imported from Panama in 1928 by Hawaii County. The birds are seen occasionally but are not known to be breeding.

Family TETRAONIDAE—Grouse

*** *Colinus virginianus*** (Linnaeus).

Bobwhite

Length 9½ to 10½ inches, the sexes similar. Upper parts reddish brown or chestnut, flecked with black, white, and tawny; rump grayish brown, finely mottled, and with a few streaks of blackish; tail ashy, the inner feathers mottled with buff; front of crown, a line from bill beneath the eye, and a band on the upper breast black; forehead and a stripe over the eye, extending down the side of the neck, white; breast and under parts white or buff crossed with irregular narrow black lines; feathers on sides and flanks chestnut, the white edges barred with black. The female has the forehead, line over the eye, and throat, buff, and little or no black on the upper breast. There is much individual variation in the plumage.

A native of the United States, east of the Mississippi, the bird inhabits brushy or lightly wooded land near water, preferring thickets near cultivated land. It feeds on weed seeds to a very great extent, but beetles, grasshoppers, and other insects are relished. The species was introduced some years ago by the Fish and Game Commission, and later, in 1928, by Hawaii County. Birds were liberated on all

the islands but are not known to have persisted anywhere except on Hawaii, where they are still seen and heard.

*** *Lophortyx californica vallicola* (Ridgway).**

Valley Quail

Length 10 to 11 inches. Male: head with a black, forward-drooping topknot; forehead buffy yellow; a white line from the forehead backwards above the eye; back of head dull brown; chin and throat velvety black, bordered by a U-shaped band of white which ends on each side just behind the eye; shoulder bluish gray mottled with black and speckled with white, the whole having a scaled appearance; back and closed wing grayish brown to bluish gray; rump and tail clear bluish gray; a buffy white stripe along the inner margin of the wing; breast clear bluish gray, behind this a buffy area, then one of reddish brown, centrally, white toward the sides, both these areas sharply scaled with black; sides brownish gray conspicuously striped with white; belly and flanks light buff, the latter broadly streaked with brown; bill black; legs and feet blackish. Female: similar but lighter in general tone, and lacking the conspicuous black and white markings of the head as well as the buffy and reddish brown ground color of the under surface; topknot much shorter and dark brown in color; general color of the head light brown; throat whitish, with narrow brown streaks.

A native of the valleys and foothills of the Pacific coast of the United States, the valley quail is principally vegetarian, feeding mostly on weed seeds and the like, taking some grain and at times becoming a nuisance in vineyards. Beetles and grasshoppers are a minor article of diet, although the young birds are more insectivorous than are the older ones. It inhabits brushy and lightly wooded country, sleeping in the trees. The species was brought from California to Oahu prior to 1855 and later was liberated on all the islands. At present it is quite common on the island of Hawaii, where it is shot every year, rather common on Molokai, and less common to very rare on Oahu, Maui, and Kauai. It has been liberated on Lanai but failed to survive.

***Lophortyx gambeli* Gambel.**

Desert Quail

Length 10½ to 11½ inches. Male: a heavy-ended recurved black crest; forehead finely streaked black and buff, this bounded by a black-bordered white bar which crosses between the eyes, then turns back and continues over the ears to the sides of the neck; back of head reddish brown; throat black, outlined by a U-shaped white band; sides of head, between the white bands, blackish brown; chest gray; upper surface, tail and closed wing pale gray brown, becoming clear gray on back of neck and tail with fine dusky streaks; sides bright chestnut streaked with white; sides of neck and nape barred dusky and narrowly streaked with reddish brown; a conspicuous black spot on the fore part of the belly, and between this and the gray chest area a broad buff band; hinder belly and flanks buffy white streaked with reddish brown; bill black;

feet and legs greenish gray. Female: crest shorter and not so broad at the tip; head chiefly grayish brown, lacking the black, white, and rufous; forehead, sides of head, and throat streaked dusky; more rusty brown on the back of the head; plumage otherwise like the male, lacking the black spot on the belly, and the chestnut of the sides paler and not so extensive. This species, frequently confused with the valley quail, differs in the reddish brown back of the head, the buffy band across the breast, the black spot on the belly, the chestnut sides, and the absence of the scaled pattern on the lower breast.

A native of the desert region of the southwestern United States and northern Mexico. In food habits and in many other ways the desert quail greatly resembles the valley quail, and the two species readily hybridize. Individuals were imported from California in 1928 by Mr. H. A. Baldwin and liberated on Kahoolawe, where they seem to have become well established.

Oreortyx picta palmeri Oberholser.

Mountain Quail

Length $10\frac{1}{2}$ to 12 inches, the sexes similar. Head, breast, and fore part of back clear bluish gray; plume or topknot of two straight narrow black feathers 2.75 to 4 inches long; extreme forehead and area between eye and bill whitish; on the throat, extending to the bill and eyes, a large patch of bright chestnut brown bordered above on each side by a narrow line of black and then by a wider white line; back, outer surface of wing, rump, upper tail coverts, and tail light olive brown; primary flight feathers outwardly edged with ashy; an abrupt white edging along the margins of the inner webs of the secondaries; elongated feathers of the sides shiny chestnut broadly and strikingly marked with black and white bands; a series of white marks high on each side of the body forming a longitudinal line; flanks light chestnut; belly whitish; bill black; legs and feet dusky. The male differs from the female in the longer plume, the clearer gray of the hind neck, and the brighter tone of the colors on the lower surface.

A native of the mountainous regions of the Pacific Coast states, the bird inhabits brushy or forested areas but is essentially a ground bird, seldom perching in the trees. Its food is mostly vegetable, consisting of weed seeds, some grain, leaves of clover and similar plants, and a small percentage of grasshoppers and other insects. This quail was imported from California a number of years ago and liberated only on the island of Hawaii, as far as is known. Later importations were made to the same island in 1932, and to Kauai in 1929. The species is not known to have become established.

***Pediocetes phasianellus columbianus** (Ord).

Sharp-tailed or Pin-tailed Grouse

Length 18 to 20 inches, the sexes similar, the male rather larger. Upper parts closely and rather evenly variegated with blackish-, reddish-, and

grayish-brown, the pattern smallest on the rump and lower back, where the blackish is mostly in sharp-angled stars; the reddish mostly on the upper back, and both the lighter colors finely sprinkled with blackish; wing coverts like upper back, but conspicuously spotted with white; crown and nape much like back; throat light buff, either plain or finely speckled; under parts white, tinted buff toward the throat; breast with large regular dark brown U- or V-shaped markings; similar but smaller, sharper and fewer spots on most of the under parts; middle of belly unmarked; sides under wings much like upper wing coverts; under coverts and axillaries white; flanks with dark brown bars or U-spots; legs and feet full feathered to between bases of toes with long grayish hair-like plumage; tail much shorter than wings, the central pair of feathers parallel-sided and square-tipped, 1 to 2 inches longer than the next pair, marked like the back; other tail feathers rapidly graduated, mottled; bill dark horn color; feet dark, the toes with one row of broad transverse scales, a row of smaller rounded scales on each side, and then a conspicuous fringe of horny processes.

A native of the north-central and northwestern parts of the United States, this bird is frequently but incorrectly called the "prairie chicken." It usually occurs where the true prairie chicken (*Tympanuchus americanus*) does not, although the ranges of the two species overlap to some extent. It is an excellent game and table bird. About 30 birds were imported from the mainland late in 1932 by Hawaii County and liberated on the island of Hawaii.

Perdix perdix (Linnaeus).

Hungarian Partridge

Length 12½ inches. Male: top of head and nape brown, striped with buff and speckled with black; back and sides of neck brownish gray, shading into brownish buff on the back, rump, and upper tail coverts, and closely marked with narrow wavy crossbars; back with faint chestnut crossbars; wings brownish buff, thickly marked with black wavy lines, spotted with chestnut and striped with buff; forehead, face, chin, and throat dull reddish; chest and breast pale gray finely marked with black; below this a wide U-shaped patch of chestnut edged above with white; rest of under parts whitish marked with black; central tail feathers closely marked with reddish buff and black, the others reddish tipped with buff; bill blackish; legs and feet bluish gray. Female: sides of head and neck brownish, narrowly striped with buff; most of the wing black with wide-set buff bars; the U-shaped mark on the breast reduced to a few chestnut spots, or absent; plumage otherwise as in the male.

A native of central Europe, now naturalized largely throughout the United States and southern Canada. Numerous attempts to establish the species in California have been uniformly unsuccessful. The bird has been introduced into Hawaii a number of times, the first time prior to 1895, then later by Mr. A. Robinson in 1910 and again in 1915, for Kauai. Mr. F. F. Baldwin brought it to Maui

in 1926, and the Fish and Game Commission imported a large number of birds in 1929, as did Hawaii County. The species is not known to have become established anywhere in the islands.

Tympanuchus americanus (Reichenbach). Prairie Chicken

Length 16 to 18 inches, the sexes similar. Male: upper parts brown, barred with black, chestnut, ocher, and whitish, the latter chiefly on the wings; sides of neck tufted with 10 or more narrow stiff feathers, rounded at the tips, which may be erected above the head, these feathers black with buff centers, frequently chestnut on the inner webs; bare yellow loose skin below these feathers may be inflated at will; tail rounded, dusky brown, tipped with white, the inner feathers somewhat mottled with buff; chin and throat buff; breast and under parts whitish, evenly barred with black; head slightly crested; legs scantily feathered in front only. Female: smaller; the neck tufts much reduced; no inflated sacs; tail with numerous distinct buff bars.

A native of the prairies of the Mississippi Valley, from central Canada south to Texas and Louisiana. There are very indefinite reports that the prairie chicken was liberated on Kauai many years ago, and 12 birds were freed on Oahu by Mr. A. S. Wilcox in 1895, but the species failed to establish itself. It is possible that the birds introduced were actually *Pediocetes*, but in the absence of definite knowledge I have assumed that they were true prairie chickens.

Family PERDICIDAE—Quail

* **Coturnix coturnix japonica** Temminck and Schlegel.

Painted or Chinese Quail

Length 6 to 6½ inches. Male: upper surface mottled chestnut and black, with conspicuous wedge-shaped white markings; closed wing similar, but much lighter; breast buff with faint flecks of white; cheek and throat pale chestnut flecked with white; abdomen whitish; sides chestnut with broad white streaks. Female: similar, but even more inconspicuous in coloration.

This is the Chino-Japanese race of the widely distributed migratory quail. Some birds were imported from the Orient in 1921 by Maui County, and liberated on Maui and Lanai. It is apparently established on Lanai and is common on Maui.

Turnix varia (Latham).

Painted Quail

Length 7½ inches, the sexes similar in markings, the female somewhat larger. Crown of head, nape and forehead rich brown spotted with white and transversely rayed with large brown markings; cheeks and a stripe over the eye white with touches of black; throat grayish; back, sides of neck, and mantle rich brown; back and rump transversely rayed with chestnut and

black; feathers of back and shoulders striped laterally with black and white; wings reddish, spotted with black and white; chest and flanks olive with triangular yellowish spots; center of abdomen yellowish; bill brown with a bluish tinge; legs and feet orange.

Native to the southern part of Australia and Tasmania, the bird inhabits sterile stony ridges interspersed with scrubby trees and moderately thick grass. It feeds on insects of many kinds, especially grasshoppers, and grain, berries, and the like. Introduced from Australia by Maui County in 1922, but its establishment on Maui is uncertain. The species failed to persist on Lanai.

Family PHASIANIDAE—Pheasants and Peafowl

Alectoris graeca chukar (Gray).

Chukar Partridge

Length 15 inches, the sexes similar. Upper parts brownish olive to ashy, tinged across the shoulders and sometimes the crown with vinous red; sides of the crown gray bordered by a buff line over the eye; shoulders ashy, striped with rufous; wing quills brown partly edged with buff; tail ashy-drab, the terminal halves of the outer feathers pale chestnut; ear coverts dull chestnut; a black band across the forehead through the eye, and continued behind the eye and around the throat as a gorget, the enclosed area buffy white with a small black spot on the chin and one on each side of the gape; breast ashy, slightly tinged with brown and washed on the sides with vinous; remainder of lower plumage buff, darkening toward the tail, the flanks barred with black and chestnut; bill and legs red.

A native of the Himalaya region of India, the bird lives by preference on open hillsides, no matter how hot and barren. In India the native saying is that the bird feeds on stones, and it is equally at home on open grassy hillsides in the low, hot valleys, on stony areas covered with barberry bushes, and among the snows at an altitude of 15,000 feet. It cannot, however, stand forest conditions with incessant damp or heavy rainfall. The food consists of grain and seeds as well as roots, green shoots, and a variety of insects and larvae. The species was introduced from the Orient in 1923 by the City and County of Honolulu and liberated on Oahu, but is not known to have survived.

Chrysolophus amherstiae (Leadbeater). Lady Amherst Pheasant

Length about 50 inches, the tail 36 inches. Male: top of head dark bronze green, with an elongate blood-red crest; cape over back of head and neck white, margined and barred across the middle with black glossed with steel blue; mantle and shoulders dark green; lower back and rump black, the feathers widely tipped with yellowish buff and with a subterminal band glossed

with dark green; shorter upper tail coverts tipped with scarlet; longer upper tail coverts white, irregularly barred with black and widely tipped with orange red; the middle pair of tail feathers white, barred and marked with wavy black lines; wing mostly black, glossed with dark purplish green; chin, throat, and fore part of neck brownish black glossed with dark green; feathers of chest like those of the mantle; breast and rest of under parts white, barred with black on the flanks and thighs; naked skin around the eye blue; bill greenish yellow; legs and feet slaty. Female: very similar to the female of *C. pictus*, except that the skin around the eye is blue.

A native of the mountains of western China and eastern Tibet. A beautiful and strikingly marked species, in great favor with avarists. Birds were imported from the mainland in 1931 by the Fish and Game Commission, and liberated on Oahu in 1932.

Chrysolophus pictus (Linnaeus).

Golden Pheasant

Length about 40 inches, the tail 27 inches. Male: crown and recumbent hairlike crest golden; a fine erectile cape of truncated nape-like plumes orange barred with blue-black; mantle dark green and purple; rump golden; flight feathers brownish, the rest of the wing purplish, chestnut and black; upper coverts and long vaulted tail black, spotted or striped with brown; shoulders and under parts scarlet; cheeks and throat chestnut. Female: smaller, length about 24 inches; head and mantle marked with black and buff; lower back and tail coverts pale brown marked with black; flight feathers dark brown marked with buff; sides of head and under parts buff, all except the chin, throat, and middle of belly barred with brownish black; tail brown, with indistinct markings of buff and black.

Like the Lady Amherst pheasant, to which it is closely related, this species inhabits the mountainous regions of southern and western China and eastern Tibet, and is also common in captivity, where it is bred extensively. The first known importation was made about 1865 by Dr. William Hillebrand. Later, about 1870, Mr. A. Robinson liberated birds on Kauai, but they failed of establishment. More recently the species has been brought from the mainland and bred at the Territorial Game Farm. Birds were liberated on Oahu in 1932.

* **Excaltatoria chinensis** (Linnaeus). King, Painted, or Button Quail

Length 4½ inches. Male: crown and upper surface brown, irregularly blotched with black, some feathers with a narrow stripe of buff in the center; wings brown, mottled; sides of head, breast, and flanks blue gray; throat black, within the black on each side an oblong patch of white, and on its lower part a crescentic white mark; abdomen rich chestnut; bill black; feet and legs yellow. Female: a broad sandy buff stripe over the eye; crown and upper surface light brown barred with darker brown, each feather, especially on the back and rump, with a buff center line; breast, sides of neck, and flanks sandy

buff, crossed by numerous crescentic marks of blackish brown. The short tail is hidden by the tail coverts.

A native of the eastern Orient, ranging south into Australia. The smallest species of the family, it prefers regions with dense and luxuriant grasses and other vegetation. Birds were imported from the Orient about 1910 by Mr. A. Robinson and liberated on Kauai, where they have become well established. Later importations were made by the Board of Agriculture and Forestry and by individuals, and the birds freed on Oahu, Maui, Molokai, and Hawaii, but the species does not seem to have become established on any of these islands, due probably to the presence of the mongoose.

Gallus gallus (Linnaeus).

Chicken

An extremely difficult bird to describe, as the range of variation in color and markings is so great. In build the wild chicken of Hawaii resembles the common barnyard fowl, but is rather longer and rangier. The prevailing colors are shades of red and brown, flecked and marbled with black and white.

The chicken was the aboriginal fowl of the Hawaiians, and was probably brought to the islands by the original Polynesian settlers. Further stock, consisting of a number of domesticated birds, was liberated by Vancouver at the end of the eighteenth century. Wild chickens were formerly rather common throughout the islands, but at the present time they are met with only on Kauai with any degree of frequency. They are very rare on Lanai, and probably extinct on Maui and Molokai. They are uncommon on Hawaii, and the occurrence of the bird on Oahu is doubtful.

Gennaeus nycthemerus (Linnaeus)

Silver Pheasant

Length 40 inches, the tail 24 inches. Male: crown, crest, and lower surface purplish black, the breast marked with white; back of neck and upper surface white, the latter with crescentic black lines; face naked, red; tail white, the lateral feathers obliquely marked with black. Female: smaller, length about 20 inches; crest blackish brown; upper surface olive brown, marked with fine dusky lines; chin and throat whitish; neck and remainder of under parts similar to the upper, except that the belly and thighs are mottled with black; outer tail feathers black, obliquely marked with white.

A beautiful species, native to southern China, and a favorite aviary bird. The first importation of record was made by Dr. William Hillebrand in 1865, and in 1870 Mr. A. Robinson released birds on Kauai. They did not, however, survive. More recently

birds have been bred at the Territorial Game Farm and were liberated on Oahu in 1932.

Pavo cristatus (Linnaeus).

Pea Fowl

Length, male, to end of tail, 40 to 46 inches; to end of full train, 78 to 90 inches; female, 38 inches. Male: feathers of the head short and curly, metallic blue on the crown, changing to green elsewhere; crest feathers with bare shafts and fan-shaped tips, black at the base, bluish green at the end; neck rich blue all around; back covered with scale-like bronzy green feathers marked with black and copper; shoulders and most of the wing barred black and buff; primary quills and coverts pale chestnut, secondaries black; train bronzy green shot in the center with coppery bronze, nearly all the feathers ending in an "eye" consisting of a purplish-black heart-shaped nucleus surrounded by blue within a coppery disc, with an outer rim of alternating green and bronze; tail dark brown; lower plumage dark glossy green, becoming black under the tail; thighs buff. Female: head rufous brown; crest shaped as in the male, the tips chestnut edged with green; upper plumage brown faintly mottled with paler; wing quills dark brown; tail dark brown, the feathers with whitish tips; lower neck metallic green; lower plumage buffy white, the inner portion of each breast feather dark brown glossed with green; a brown patch under the tail; naked skin of the face livid white; bill and legs horny brown.

A native of India and Ceylon, living in fairly thick jungle and moving out into cultivated areas to feed. The bird takes a variety of food, eating such vegetable matter as grain and seeds, as well as insects and larvae of all kinds, snails, and lizards. The peafowl is a favorite aviary bird and is frequently used as an ornament on large estates. It is classed as a game bird, although only the young birds are really fit to eat. The species was formerly much commoner in the wild in Hawaii than it is today. It never became thoroughly at home, and indiscriminate shooting nearly exterminated it before the authorities declared a permanent closed season. The first introduction of record was made by Mrs. Frances Sinclair of Kauai in 1860, yet it is not unlikely that they had been brought here before that time. Peafowls still persist in a wild state, although in small numbers, on Oahu, Maui, Molokai, and Lanai. They are reported to be fairly common on Niihau and in Kalalau Valley, Kauai. There are several flocks on the Puuwaawaa Ranch, Hawaii, liberated in 1928 by Mr. Robert Hind.

Phasianus mongolicus Brandt.

Mongolian Pheasant

Length about 36 inches, the tail 22 inches. Male: head dark iridescent green; a white collar around the neck, interrupted in front; mantle, shoulders, chest, and breast bronze red with purple and green reflections; lower back and rump dark iridescent green to purple; chin and throat purplish bronze red;

chest, breast, and flanks tipped with very dark green; middle of breast and sides of belly dark green. Female: smaller; plumage brown, marked with black and buff; each feather of the upper mantle with a subterminal black spot and a black bar across the middle. The females of all these pheasants are very similar in coloration and markings, and no description is adequate for distinguishing them without going into minute detail.

A native of Russian and Chinese Turkestan, and a well-known aviary and game bird. This species, frequently confused with the ringneck (*P. torquatus*), is recorded as having been brought to Hawaii by Dr. William Hillebrand in 1865, and later by Mr. A. Robinson in 1880, these latter birds being liberated on Kauai. There are rather indefinite reports of its introduction in 1909, and in 1929 the Fish and Game Commission imported birds. It is not known to be established in Hawaii as a true species but is believed to have hybridized rather extensively with the ringneck.

* **Phasianus torquatus** Gmelin. Chinese or Ringneck Pheasant

Length 33 inches, the female much smaller. Male: whole bird conspicuously iridescent. Top of head greenish gray bordered with white, and two dark iridescent tufts above the ears; area around the eye nearly bare; upper neck and throat dark iridescent; a conspicuous white collar; breast iridescent bronze flecked with black; upper part of back mottled with black and white; central part of back and upper part of wing chestnut mottled with black and white; lower part of back and rump gray-green mottled with dark iridescent and buff, steel blue toward the sides; sides buff with large dark iridescent spots; tail long, narrow, pointed, gray-green barred with black, the edges toward the base pinkish brown barred with chestnut; abdomen dark iridescent; bill yellow; legs and feet brown. Female: head and upper plumage mottled buff, brown, and black; shoulder area chestnut, buff and black; throat and abdomen light buff with minute black flecks; neck and breast mottled buffy brown and black; rump and tail buffy brown marked with black.

A native of eastern Asia, from southern Siberia through Manchuria, eastern Mongolia, and Korea to about the region of Canton, China. The species prefers open or brushy land with rank-growing vegetation, and moist thickets and swampy land. It feeds on weed seeds, waste grain, and wild fruits, as well as on nearly all the common insects. In Hawaii the birds are very fond of the common black ground roaches (*Pycnoscelus surinamensis*) and inhabit mostly the open and drier grasslands and cactus scrub. The species was introduced into Hawaii many years ago, probably by Dr. Hillebrand in 1865, although I find no note to that effect. It is well established on all the islands.

*** *Phasianus versicolor* Vieillot.**

Japanese, Blue, Green, or Versicolor Pheasant

Length about 26 inches. Male: head iridescent green; hind neck iridescent purple; shoulders iridescent green; tail rather short, gray barred with black in the center, the sides purplish gray; upper part of wing bronze, marked with black and white, then a gray area, the lower section of this marked with large spots of maroon; flight feathers brown marked with pale buff; throat iridescent purple; breast dark iridescent green; rest of under parts dark brown with flecks of dark iridescent green. Female: much like the female of *P. torquatus*, except that the feathers of the mantle are almost entirely black in the middle, and the green tips of the feathers are well marked; the black bars on the feathers of the chest, breast, and flanks are more strongly marked.

A native of the mountains of Japan. The species was introduced into Hawaii many years ago, certainly prior to 1900. There is a note that eight Japanese pheasants, including the golden, were imported in 1869, and this species may have been among them. There are indefinite records of importations about 1907 and 1909, and birds were brought in by Territorial officials in 1928 and 1929. The birds have been liberated on practically all the islands and are known to exist on Oahu, Maui, Hawaii, and Kahoolawe. They have hybridized extensively with the ringneck, and obvious hybrids are occasionally encountered.

*** *Phasianus (torquatus × versicolor)*. Hybrid Pheasant**

This natural hybrid is a form occasionally met with in the islands, and is sometimes confused with the true *P. versicolor*. A male specimen in Bernice P. Bishop Museum shows its origin plainly, and may be roughly described as follows, basing the description on *P. torquatus*:

Size same as *P. torquatus*; iridescence like both parent species; top of head without the white border; the white collar reduced to a very narrow, obscure line; breast dark green; upper part of back black mottled with buff; central part bronze rather than chestnut, with the same mottling; sides and flanks flecked with black and bronze; sides of tail feathers bronzy, the central green and black area much narrower proportionately.

*** *Rollulus roulroul* (Scopoli). Red-crested Wood Partridge**

Length 10 to 11 inches. Male: fore part of head black, with a frontal tuft of long black bristles; a white band separating the black area from the occipital part, which bears a full, hairy, maroon crest; upper surface dark green glossed with blue; upper part of wing maroon; flight feathers brown and buff; tail and under parts black, with a blue tint on the breast; base of bill black; feet and naked orbits scarlet. Female: head blackish with a moderate crest; body grass green; upper part of wing chestnut edged with maroon; bill black.

A native of the Malay Peninsula, Siam, Borneo, Java, and Sumatra, living in the dense forests at a moderate elevation. It feeds on seeds, berries, and insects. A few individuals were imported from Singapore in 1924 by the City and County of Honolulu and liberated on Oahu. They have apparently disappeared.

*** *Syrmaticus soemmerringii* (Temminck).** Copper Pheasant

Male: length 50 inches, the tail 37 inches; general color above chestnut, the margins of the feathers of the mantle, chest, shoulders, lower back, and rump glossed with purplish carmine with fiery gold reflections; flight feathers dark brown marked with black and pale chestnut; central tail feathers chestnut barred with black and paler chestnut; outer tail feathers chestnut tipped with black. Female: smaller, length 21 inches, the tail 7½ inches; top of head blackish brown marked with reddish buff; neck and mantle reddish, coarsely mottled with black, the shoulders similar; lower back and rump reddish sandy, mottled with black; under parts pale buff to reddish gray, marked with black; outer tail feathers chestnut tipped with white, and a subterminal band of black.

A medium-sized bird, native to Japan. This species has been introduced from Japan by the Fish and Game Commission at various times between 1907 and 1914 and liberated on Oahu, Maui, and Kauai. It is not known to be established anywhere in the islands as a species but is believed to have interbred with the ringneck (*P. torquatus*).

Family NUMIDIDAE—Guinea Fowls

***Numida galeata* Pallas.**

Guinea Fowl

Length 25 inches, the sexes alike. A bony helmet; general color of plumage dark gray to black, thickly speckled with white; a wide collar of reddish gray covering the upper part of the mantle and chest; bare skin on sides of face and neck, chin and wattles red, rest of neck bluish; legs and feet dusky red.

A heavy-set, chunky bird, native to western Africa and the adjacent islands. It feeds on animal and vegetable matter in general and is a good game and food bird. The guinea has been liberated in the islands on several occasions but has always failed to survive in the wild. There are records, more or less definite, of liberations on Kauai as early as 1874, and on Molokai in 1908, on Lanai in 1914, and on Hawaii, Maui, Kauai, and Oahu in 1928, 1929, and 1930. These birds were, of course, of domesticated stock. The species has been bred from time to time at the Territorial Game Farm for distribution among the islands.

Family MELEAGRIDAE—Turkeys

Meleagris gallopavo Linnaeus.

Turkey

Length about 4 feet. Male: head and upper neck naked; plumage with metallic bronze, copper, and green reflections; primaries black barred with white, secondaries green barred with whitish; a tuft of long bristles hanging from the center of the breast; bill red, like the skin of the head; legs red and spurred. Female: smaller, dull of plumage and lacking the breast tuft. The true wild turkey is distinguished from the domestic bird chiefly by the chestnut rather than white tips to the feathers of the tail and upper tail coverts.

A native of North America, inhabiting the open forests and grasslands, a habitat which it maintains in Hawaii. The food consists of insects, grain, and vegetable matter generally. The turkey is an escape from domestication and has been present in a wild state for many years. It is recorded that the first turkeys were brought to Kailua, Hawaii, from Coquimbo, Chile, by Capt. John Meek in 1815. The bird is not nearly so common as in past years, but is present in small numbers on Oahu, Maui, and Lanai; on Hawaii 2,000 to 3,000 birds are taken annually. It has not recently been reported from Kauai, and is believed to be extinct on Molokai. What I believe to be the true wild form has been imported several times under the name of "Mexican turkey," but has apparently failed to survive as a distinct variety. It has probably lost its identity through interbreeding with the common form.

ORDER GRUIFORMES

Family RALLIDAE—Rails, Coots, and Gallinules

* **Porphyrio melanonotus** Temminck

Mud Hen; Alae-iwi

Length about 18 inches, the female somewhat smaller. Cheeks, back of head, center of abdomen, and thighs sooty black; back of neck, breast, and flanks rich deep indigo blue; back, wings, and tail deep shining black; frontal plate, bill, legs, and feet red.

A native of Tasmania and Australia, living in marshy lands and along rivers, feeding on snails, insects, grain, and various animal and vegetable substances. The species was imported from Australia many years ago and liberated on Oahu, where it is well established, although nowhere common. It is not known to occur on any of the other islands. Reports of the occurrence of this species on islands other than Oahu seem to be the results of a confusion of the *alae-iwi* with the native *alae-ula*, *Gallinula galeata sandvicensis* (Streets), or with the *alae-keokeo*, *Fulica alai* Peale.

Porphyrio poliocephalus (Latham).

Indian Blue Gallinule

Length 17 inches, the sexes alike. Head pale brownish gray, tinged with cobalt on the cheeks and throat and passing on the nape into the deep purplish lilac of the upper plumage, flanks, and abdomen; sides of wing and breast light greenish blue; wing and tail feathers black, the exposed portions blue; a white patch under the tail; bill and casque deep red mixed with brown; legs pale red, brown at the joints. The bill is thick and compressed, rather short and high, and terminates in a broad frontal shield or casque, square across the crown; the legs and toes are broad and ungainly.

A native of Asia, from the Caspian Sea to Siam, inhabiting swampy land where there are plenty of rushes, bushes, and weeds. It lives within the reed beds, rarely coming out of the cover. Its food is mainly vegetable in character, and the bird is capable of doing great damage to growing rice. Individuals were imported from dealers in San Francisco in 1928 by Hawaii County and liberated on that island as game birds. The species is not known to be established.

*** Porzanula palmeri** Frohawk.

Laysan Rail or Crake

Length about 6 inches, the sexes alike. Above light brown, many of the feathers with blackish centers; sides of head and neck, chin, throat, breast, and abdomen slate gray; eye red; bill, legs, and feet green; wings almost rudimentary.

This little species, formerly endemic to Laysan Island, is now in all probability extinct there, but is fairly common on Midway. It is completely flightless and feeds on insects, the flesh of dead birds, the eggs of sea birds, when they are opened by some other stronger-billed bird, seeds, and the like. A number of individuals were brought from Laysan Island in 1904 and liberated on the lands of the Oahu Sugar Company for the purpose of assisting in the destruction of the cane leafhoppers (*Perkinsiella saccharicida*), but they did not persist. I have been unable to locate any published records of this introduction, which is, so far as I can determine, the only definite attempt ever made to transplant any of the endemic species of Hawaiian birds. My only knowledge of it is derived from the label on a preserved specimen of the rail found in a cupboard at the Experiment Station, Hawaiian Sugar Planters' Association.

ORDER CHARADRIIFORMES

Family LARIDAE—Gulls and Terns

Larus novae-hollandiae Stephens.

Silver Gull

Length 15 inches, the sexes alike. Head, neck, under surface, rump, and tail white; back and wings delicate gray; primaries white, eccentrically marked with narrow black lines; bill, legs, and feet blood red.

A native of the seacoasts of Tasmania and southern Australia in general, as well as of rivers and inland waters, where it feeds on fish, crustaceans, and the like, together with insects and larvae. It has been known to raid bird nests and eat the eggs and young. Several individuals escaped from the Honolulu zoo in 1924, when their cage was overturned in a heavy windstorm. Although they were seen for some months thereafter flying over the harbor, they have apparently failed to survive, as they have not been reported for several years.

*** Larus occidentalis** Audubon.

Western Gull

Length about 24 inches, the sexes alike. Head, neck, rump, upper tail coverts, tail, and entire under parts white; back and wings neutral gray, most of the feathers broadly tipped with white, and darker on the outer edges; bill deep yellow, the mandible with a subterminal lateral spot of red; the bare orbital ring vermilion; legs and feet yellow. The young are mottled brown and whitish, buffy on the lower abdomen.

The species ranges along the Pacific coast of North America from British Columbia to Mexico, and occasionally inland. It feeds on various kinds of aquatic life and is a useful scavenger around the harbors. This gull has been brought to Hawaii at various times and liberated at Honolulu and Hilo, but it has always failed to persist.

ORDER COLUMBIFORMES

Family COLUMBIDAE—Doves and Pigeons

*** Caloenas nicobarica** (Linnaeus).

Nicobar Pigeon

Length 15 inches, the sexes alike. Top of head blue-black; a number of long slender blue-black feathers forming a cape over the shoulders; back and wings metallic green and bronze; flight feathers, throat, and breast blue-black; abdomen dark metallic green; tail white; bill black, with a prominent swelling at the base; feet blackish. In young birds the bronzy color predominates on the upper surface, and the tail is black.

A native of the Nicobar Islands, extending through the Malay Archipelago to the Solomons. The species is partly terrestrial, feeding mainly on seeds. A few individuals were imported from Australia by Maui County in 1922, and into Kauai in 1928. A few birds are kept at the Territorial Game Farm, but the species is not known to be breeding in the wild.

* ***Chalcophaps indica*** (Linnaeus). Green-wing or Beetle-wing Dove

Length about 8 inches, the sexes alike. Head, breast, and shoulders brown with iridescent purplish-gray lights; wings and center of back dark metallic green; flight feathers brown; back and rump brown-black, crossed by two grayish bands, iridescent green between; tail brown-black; abdomen lighter purplish gray; bill red; feet and legs pink.

A forest-loving species, native to Australia and the Malay region. The food consists principally of fruits and seeds. A few birds were purchased from Singapore in 1924 by the City and County of Honolulu, and freed on Oahu. They are not known to have survived.

Columba livia Bonnaterra

Rock Dove or Pigeon

Length 13 inches, the sexes alike. Plumage slaty gray almost throughout; neck glossed all around with metallic green and purple; back and wings rather darker in tint and sometimes a paler bar across the rump, in some individuals white; two black bars across the wings; tail with a broad black bar across the end and with a white patch at the base of the outer feathers; under surface of the wings very pale gray to white; bill black, the base swollen and nearly white; legs reddish.

A native primarily of the Mediterranean region, but ranging widely. This species is the wild form of the common domesticated pigeon, which, however far it may have departed from the original coloration during generations of breeding under controlled conditions, tends to revert to the original form rather rapidly when controls are removed. The birds feed mainly on grain and seeds and occur, frequently in great numbers, wherever buildings or holes in the cliffs afford nesting places. The domestic pigeon is reported to have been introduced into Hawaii in 1796, and it is certain that it went wild almost immediately. The bird was reported as very common on Hawaii in 1891, as it is at the present time. It is less common, but frequently met with, on Oahu, rare on Molokai and Lanai, and very rare on Maui. There exist any number of varicolored pigeons that have severed all connection with domestication,

but I am considering here only those that have reverted to the wild form.

***Gallicolumba luzonica* (Scopoli).**

Bleeding-Heart Dove

Length 10 inches, the sexes alike. Forehead gray; top of head and back sooty; back of neck and upper back dark iridescent greenish; lower back and rump sooty; upper wing gray with two black crossbars; flight feathers brown; tail sooty; throat, breast, and abdomen white, with a conspicuous blood-red spot in the center of the breast, this deeper-colored in the center shading out somewhat toward the edges; bill black; feet pink.

A native of the Philippines and a favorite aviary bird because of the conspicuous and peculiar marking that gives it its common name. A few individuals were imported from the Philippines by Mrs. Dora Isenberg in 1929 and liberated on Kauai. The species is not known to have become established.

***Geopelia cuneata* (Latham).**

Diamond Dove

Length $7\frac{1}{2}$ inches, the sexes similar, the female somewhat the smaller. Male: head, neck, and breast gray, passing into white on the abdomen; back and shoulders cinnamon; wing coverts dark gray, each feather of the upper part of the wing with two spots, white encircled with black, near the tip; flight feathers brown; the four center tail feathers gray, deepening into black at the tips, the other tail feathers grayish black at the base, otherwise white; an area of naked skin around the eye light scarlet to greenish yellow; bill dark olive brown; feet flesh or yellowish. Female: upper surface browner; wing feathers darker; wing spots larger; spotting of the upper surface not so heavy or regular.

A native of Australia, exceedingly tame and docile. It feeds on grass and weed seeds and the like. A few individuals imported from Australia by the Board of Agriculture and Forestry in 1928 and liberated on Oahu are believed to have died. An importation from Los Angeles, made by Hawaii County in 1929, is thought to have been of this species. The birds were purchased as "triangular-spotted pigeons." It is not known whether or not they will succeed in maintaining themselves.

***Geopelia humeralis* (Temminck).** Bar-shouldered or Zebra Dove

Length 8 inches, the sexes alike. Forehead, cheeks, sides of neck, and breast gray; occiput, back, closed wing, and rump silky brown; back of neck reddish; each feather of the upper surface with a narrow black band at the tip, giving the whole a scaled appearance; under surface of shoulder fine rusty red; outer half of wing feathers brown; two center tail feathers dark gray, the others reddish brown at the base, increasing in intensity toward the tip, largely

tipped with white; rest of under surface washed with reddish, naked skin around the eye purple; bill and nostrils bright blue; legs and feet pink.

A native of Australia, inhabiting the open country and feeding on seeds. The birds are very tame and quiet, and in Hawaii they walk along the streets and roads, hardly moving out of the lines of traffic. The species was imported from Australia in 1922 by the City and County of Honolulu for liberation on Oahu, and by Mrs. D. R. Isenberg for liberation on Kauai, on both of which islands it is well established. A few individuals were taken to Maui in 1928 by the Fish and Game Commission, but nothing is known as to its status there. Several individuals, which I assume to be merely color variants of this species, have been seen associating with flocks of normally colored birds. In these the reddish coloration of the abdomen has replaced the gray on the breast either wholly or in part. These birds have been called locally "red-breasted doves."

* ***Geopelia tranquilla*** Gould.

Blue-eyed or Peaceful Dove

Length $8\frac{1}{2}$ to 9 inches, the sexes alike. Face and throat gray; occiput, back, and wings ashy brown marked with black; flight feathers dark brown; under surface of shoulders chestnut; chest, sides, and back of neck gray, crossed by many narrow black lines; abdomen and flanks vinous; four center tail feathers brown, the others black, largely tipped with white; bill and naked skin around the eye bright gray-blue. A specimen in Bernice P. Bishop Museum is labeled *G. placida*, a very closely allied species which I do not believe was ever brought to Hawaii.

A native of Australia, very similar in appearance and habits to *G. humeralis*. Birds were purchased from Australia in 1922 by the City and County of Honolulu and by Maui County. The species is rather sparingly established on Oahu and doubtfully so on Molokai. The birds were at one time rather common on Lanai, but seem to be dying out. A dove, possibly of this species, was liberated on Kauai in 1920 by Mrs. Dora Isenberg, but failed of establishment.

Geopelia species.

Pink-eyed Dove

A species of dove of which I have seen no specimen and which I cannot identify, but which is in all probability a *Geopelia*, was imported from Australia by Maui County in 1922. The birds were liberated on Lanai but failed to maintain themselves.

Geophaps smithi (Jardine and Selby).

Squadda Pigeon

Length 11 inches, the sexes similar. Head and entire upper surface olive brown; throat white, the tips of the last feathers gray, forming a surrounding

margin of that color; a large naked area around the eye bright reddish orange; on the cheek a large brownish gray spot, nearly insulated by the large space of the eye being surrounded by a narrow white band, the feathers black-tipped; chest reddish brown, in the center of the breast a few feathers clear gray, margined at the tip with black; breast and abdomen purplish olive-brown; flanks white; lower abdomen buff; wings dark brown with touches of iridescent purple; two center tail feathers olive brown, the others deep slate gray at the base and black at the tip; bill blackish gray.

Native to Australia. A strictly terrestrial species, inhabiting meadows covered with short grass near water, or the edges of burnt brush lands. Imported from Australia by Maui County in 1922 and liberated on Maui and Lanai, the species has probably failed of establishment.

* *Leucosarcia picata* (Latham).

Wongawonga Pigeon

Length 16 inches, the sexes alike. Area near the base of the beak black; forehead and chin white; entire upper surface, wings, and tail deep slate gray; flight feathers brown; three lateral tail feathers on each side white-tipped; sides of head light gray, shading into grayish black on breast; a broad V-shaped white marking on the breast; abdomen and flanks white, the latter with a triangular black spot near the tip of each feather; tip of bill purplish black, base and operculum reddish; legs and feet bright pink-red.

A native of the brush lands of New South Wales, the bird rarely comes out in the open, preferring the continuous shade of the forests. It is a ground feeder, living on fallen fruits, seeds, and the like. A few birds were released on Lanai about 1922, and possibly some on Maui at the same time, having been purchased from Australia by Maui County. It is not known that any have survived.

Lophophaps plumifera (Gould).

Plumed Bronze-wing or Spinifex Pigeon

Length $8\frac{1}{2}$ inches, the sexes alike. Bare skin near base of bill and around eye crimson or orange red, edged above and below with black; forehead and a line above the black one gray; center of crown and crest cinnamon; chin and lower part of neck black; center of throat and ear coverts white; chest rich cinnamon bounded below by a crescentic band of white, to which succeeds a narrow one of black; center of abdomen white; flanks cinnamon; closed wing brown, some feathers with an oblong purplish metallic mark; back of neck and mantle rayed alternately with cinnamon and brown; feathers of upper portion of wings rayed with cinnamon, blackish brown and gray; basal half of tail feathers cinnamon, apical half black, tips white; bill olive black.

Native of the southern part of Australia, the species inhabits open land near water. Its food consists principally of seeds, berries, and the like. A few individuals, obtained from Australia in 1922, were

liberated by Maui County officials on Maui and Lanai but apparently did not survive.

Ocyphaps lophotes (Temminck).

Crested Bronze-wing Pigeon; Australian Crested Dove

Length $12\frac{1}{2}$ inches, the sexes similar. A long slender black crest; plumage in general grayish olive brown; wing coverts shining bronzy green tipped with white; a metallic purple gloss on the secondaries; the two middle tail feathers brown, the outer two peacock blue, white-tipped, the others brown glossed with green.

A gregarious Australian species, found near water. A few individuals, purchased from Australia in 1922, were liberated on Oahu by the City and County of Honolulu, and on Lanai and Molokai by Maui County. They apparently did not survive except possibly on Molokai, where they were seen four or five years ago.

Phaps chalcoptera (Latham).

Bronze-wing Dove

Length $13\frac{1}{2}$ inches, the sexes similar. Upper surface generally grayish brown; a purple band on the crown and brilliant bronze and green spots on the wings; breast pinkish; throat white; forehead white with a wash of yellow.

A native of Australia. A few birds, purchased from Australia in 1922 by the City and County of Honolulu, were liberated on Oahu, but evidently did not survive.

* **Spilopelia chinensis** (Scopoli).

Turtle, Lace-neck, Ringneck, or Chinese Dove

Length 12 inches, the sexes alike. Top and sides of head gray; back and sides of neck black, conspicuously spotted with white; upper plumage brown, spotted on the upper back and wings with rufous; an ashy band on the outer edge of the wing; the two middle pairs of tail feathers brown, the others black with gray or white tips, these very conspicuous in flight; cheeks and lower plumage vinous, whitish on the throat and under the tail; eye reddish, as is the skin around it; bill dull lead-black; legs and feet dark purplish red.

A native of eastern Asia, extending from China to India and Sumatra. It is found in almost every type of country where water is easily accessible, and feeds on grain and seeds. At times the birds congregate in small flocks, but it will be noticed that they are in couples. They appear to pair for life, as the pairs keep much together, flying and feeding in company and resting side by side in the trees. The species was brought from the Orient, presumably China, many years ago. It is a game bird, and a favorite article of diet with the Chinese. It is known that the Chinese frequently

keep doves and pigeons in captivity, breeding them for food purposes; the assumption, in the lack of definite evidence, is that birds imported and kept for this purpose escaped and established their species. They are widely distributed throughout the islands, and were reported as being very common on Oahu in 1879.

Starnoenas cyanocephala (Linnaeus). Blue-headed Quail Dove

Length 11 to 12½ inches, the sexes alike. Plumage in general dull gray to olive brown above and dull rusty beneath; breast with a purplish tinge; top of head bright blue; throat blackish, bordered with white; a white band between the ears under the eyes and under the bill; a black band from the bill through the eye; bill coral red at the base, blue-gray at the tip; legs and feet red.

A native of Cuba and the Florida Keys. A few individuals were imported in 1928 by Mr. D. M. Johnson for breeding and eventual liberation. I am not familiar with their final disposition.

Streptopelia decaocto (Privalszky).

Indian Ring or African Ringneck Dove

Length 12 inches, the sexes alike. Head and neck gray with a lilac tinge; a black collar narrowly bordered with white around the hind neck; upper plumage light brown passing into ashy gray on the wings; outer flight feathers dark brown; central tail feathers light brown, the others gray and blackish brown with broad white tips; breast pale lilac passing through ashy gray into slate gray under the tail; wing lining white; eye crimson; bill black; feet dark pink-red.

A native of India and Burma, extending west to the Balkan peninsula, east to Yunnan Province of China, and north to Turkestan. A bird of the open country, where scattered trees, large bushes, or hedges provide shelter. It is very tame and friendly, too much so for its own good, and feeds on grain and the seeds of various grasses and weeds.

The first introduction of the species was made by Mrs. D. R. Isenberg for Kauai in 1920. Later, in 1928, birds were liberated on Oahu by Mr. W. H. McNerny, and in 1928 and 1929 further introductions were made, from the Orient, by the Board of Agriculture and Forestry, these likewise being freed on Oahu. In 1928 a number of birds were brought from San Francisco by officials of Hawaii County, purchased with funds raised by popular subscription, and liberated on the island of Hawaii. The bird is known to be breeding in small numbers on Kauai and Oahu, but nothing definite is known as to its status on Hawaii.

Zenaidura macroura (Linnaeus).

Mourning Dove

Length about 12 inches, the sexes similar. Upper parts mainly grayish blue, shaded with olive brown; head and neck brown with a bluish sheen; sides of neck iridescent reddish and gold; a black spot below the ear; outer tail feathers bluish with a black bar and white tip, the central pair dark; lower parts faint purplish, changing to buff on the belly, bluish on the sides, and whitish on the chin; eye brown; bill black; legs and feet purplish red.

A native of North and Central America, from southern Canada to Panama. The food consists almost entirely of seeds, mostly those of noxious weeds. Several birds were brought to Hawaii by Mr. D. M. Johnson in 1929 or 1930, for breeding and eventual liberation. I do not know their present status.

Unidentified.

Javanese Dove

A species of dove which I have not seen and therefore cannot identify was purchased under the name "Javanese dove" from Singapore in 1924 by the Fish and Game Commission. The birds were liberated on Oahu, but nothing further is known of them.

ORDER PSITTACIFORMES

Family PSITTACIDAE—Parrots, Parrakeets, and Cockatoos

Brotogeris jugularis (Müller).

Tovi or Beebee Parrakeet

Length 9 inches, the sexes alike. General color bright grass green, the back faintly washed with bronze; under parts yellowish green; a patch of bright orange on the chin; wings with a bronze slash above, bright blue beneath; tail feathers tapering to rounded or pointed tips; bill and feet flesh color; bare skin whitish.

A native of Panama, whence large numbers are shipped as cage birds. On several occasions I have seen birds of this species free in Honolulu, but know of no instance of their attempting to breed or even persisting in the wild.

Cacatua galerita (Latham).

Sulphur-crested Cockatoo

Length 18 to 20 inches, the sexes alike. Plumage white, the base of the inner web of quills and tail feathers pale sulphur yellow, like the base of the feathers of the head and neck; a large sulphur yellow crest; ear coverts tinged with sulphur yellow; naked skin around the eyes white; bill and feet black.

A native of Australia and Tasmania, and popular as a cage bird. Individuals escaped from captivity have been seen from time to time in Honolulu, but there is no report of their persisting for any length of time or of their attempting to breed.

Cacatua roseicapilla Vieillot.

Rose-breasted Cockatoo

Length 14 inches, the sexes alike. Crown pale rosy white; upper surface gray, deepening into brown at the extremity of the quills and becoming nearly white on the rump; neck and all under surface from below the eyes rich deep rosy red; tail gray, darker below; bill white; feet dark brown.

A native of Australia, and like the sulphur-crested cockatoo an occasional escape from captivity. Like it also, this species has not been known to persist for any length of time in the wild.

Macrocercus macao (Linnaeus).

Red-and-Blue Macaw

Length 36 inches, the sexes alike. Head, breast, and upper back scarlet red; lower back, rump and tail coverts pale blue; smaller wing coverts scarlet, the others and scapulars yellow tipped with green; quills blue above, golden red beneath; tail feathers scarlet with black shafts, the central pair scarcely tipped with blue, the blue tips increasing in extent on the outer feathers, the outside ones being almost wholly blue; tail golden red beneath; upper mandible white, blackish at the tip and edges, lower mandible black; naked flesh of cheeks dusky; feet blackish.

A native of tropical America from Mexico south to Bolivia and the Amazon valley, this macaw is occasionally seen in large private aviaries or in semi-public buildings where a spectacular splash of color is wanted. I have seen at least two birds that have escaped from captivity in Honolulu, but they apparently did not persist.

Melopsittacus undulatus (Shaw).

Love Bird; Shell or Grass Parrakeet

Length $7\frac{1}{2}$ inches. Male: crown, cheeks, and throat yellow; on the cheek an oblique band of rich blue, and below this three circular black spots; upper back, shoulders, and wing coverts yellow marked with black crossbands; lower back, rump, tail coverts, and under surface grass green tinged with bluish on the upper and under tail coverts; wings brown marked with bluish green and greenish yellow; the two central tail feathers blue, the others crossed by an oblique band of yellow; cere blue; bill and feet slaty. Female: the same, except that the cere is brown or gray. There are on the market now many varieties of this species, varying in color from almost white through light blue to almost indigo, and straw to greenish yellow.

A native of Australia, and a most popular pet, as with a little care to accommodations it breeds freely in captivity. Birds have escaped in Honolulu from time to time, and probably on the other islands as well. I have heard no reports of their attempting to nest or breed in the wild, or even of their persisting very long, although it is probably merely a matter of time until the love bird will establish itself in Hawaii.

*** *Platycercus palliceps* Vigors.**

Pale-headed or Blue-cheeked Parrakeet

Length about 12 inches, the sexes alike. Crown white to gamboge yellow, in some individuals a fine scarlet line across the forehead and the lower part of the cheeks deep blue; nape, back, and shoulders scaled with gamboge yellow and black; rump in some individuals greenish blue, in others strongly tinted with gamboge yellow; upper part of wing black, the tip brown, along the edges iridescent blue to purple, beneath pale brown with a whitish crossbar; under surface of the body greenish blue, except for the scarlet under tail coverts; the two central tail feathers greenish blue, the basal half of the others blackish brown on the internal webs and rich deep blue on the outer webs, the terminal half delicate pale blue, white at the tips; bill horn-colored; feet dark brown.

A native of eastern Australia, feeding on seeds, grain, and vegetable matter in general. A single pair was liberated by Capt. James Makee about 1877 near Ulupalakua, Maui. Capt. Makee has stated that they stayed near the house until they had raised one chick, and that the three then went into the forest. They have multiplied, but the birds are not numerous and are restricted to the Olinda district of Maui at an altitude of about 6000 feet, feeding in the grasslands at the edge of the forest in the depths of which they live. This species has been referred to in the literature as the blue-cheeked parrot or parrakeet, but this name properly belongs to a closely related species. *P. cyanogenys* (Gould). As only one species is present in Hawaii, however, this transference of the common name should cause no confusion.

***Psittacula krameri* (Scopoli).**

Indian Green Parrakeet

Length 16 inches. Male: upper plumage bright green, washed with pale bluish gray about the back and sides of the head and paler about the bend of the wing; median tail feathers green at the base, then bluish gray, the others green with yellow inner webs, yellow-tipped; a fine black line from the nostril to the eye; a rose collar around the neck except in front; chin and a band from the lower base of the bill to the collar black; lower plumage yellowish green; bill cherry red, the lower mandible blackish; feet dusky slate or greenish. Female: similar, except that the rose collar and black band are replaced by an indistinct emerald ring.

A native of the Indian plains, gregarious and capable of doing great damage in gardens and fields. It is an almost universal cage bird. On several occasions individuals, and once a flock of five, have been seen free in Honolulu. The species is, however, not known to be on the way to establishment.

In addition to the birds listed here, there are undoubtedly other species of parrakeets and parrots that have escaped from time to time and have persisted for a while in this accidental freedom, but I have included here only those that I have seen loose. With the single exception of the pale-headed parrakeet they have certainly not become established anywhere in the islands.

ORDER PASSERIFORMES

Family ALAUDIDAE—Larks

* *Alauda arvensis* (Linnaeus).

Skylark

Length 7 inches, the sexes similar. Upper surface and closed wing mottled with buff and brown; throat light buff flecked with brown, the neck similar but with larger flecks; abdomen light buff; sides light brown; tail feathers brown edged with buff; bill dark brown; legs and feet brown.

A native of western Europe and the British Isles, and one of the renowned song birds of the world. The first introduction record gives the date 1865, when 10 birds were brought from England, but I find no mention of the name of the introducer or the place of liberation. In 1870 Mrs. Frances Sinclair liberated skylarks on Kauai, and in the same year Hon. A. S. Cleghorn imported some from New Zealand and freed them on the high table-land at Leilehua, Oahu. Subsequent importations from New Zealand were liberated at Moiliili, Oahu. Later, birds were taken from Oahu to Kauai, Maui, Molokai, Lanai, and Hawaii, and the species is now well established throughout the islands. The bird is known to be on Niihau, and is even nesting on the tiny islet of Lehua. The skylark is a valuable addition to the island avifauna, both economically and esthetically.

Melanocorypha mongolica (Pallas).

Mongolian Lark

Length about 8 inches, the sexes similar. Upper parts brown streaked with black; crown of head and hind neck chestnut, a light patch in the center of the crown; a broad white eyebrow produced backwards to join a creamy buff band around the nape; a large patch on the sides of the fore-neck, which patch meets across the fore-neck to form a distinct collar, very narrow in the center; considerable white on the wings; under parts white; breast and thighs chestnut; tail black marked with white.

A native of eastern Siberia and northern China and a favorite cage bird with the Chinese, many thousands being brought from

Mongolia into China proper. The species was imported about 1914 by Mrs. D. R. Isenberg and freed on Kauai, where it is well established about Kilohana crater and in the Lihue district. A bird known as the "Japanese lark" was brought in by Mrs. Isenberg about 1898 and again in 1904. It apparently did not become established, hence nothing further is known about it. The supposition is that it was of this same species.

Family PARIDAE—Titmice

Parus major Linnaeus.

European Great Tit; Kohlmeise

The validity of vague reports that this species was liberated on Kauai many years ago is settled by Mrs. Isenberg, who writes that the bird brought from Germany by Mr. Richard M. Isenberg in 1905 was not the German or European tit but the Japanese species, *P. varius*.

Parus varius varius Temminck and Schlegel.

Japanese Tit; Yamagara

Length 5 inches. Male: forehead, cheeks, ear coverts, and sides of neck cream-colored; chin, throat, crown, and hind neck black, except for an irregular longitudinal white spot on the occiput and nape; upper part of mantle chestnut; closed wing, back, and tail bluish gray, touched with white; breast, abdomen, and flanks chestnut; an irregular band or patch of light buff separating the black of the throat from the chestnut of the upper breast. Female: slightly smaller and duller in color.

A native of Japan. A very active and acrobatic little bird, and very friendly. It lives in the open woods, feeding on scale bugs, caterpillars, and other small insects. It is reported as having been first imported from Japan by Mrs. Frances Sinclair about 1890 and liberated on Kauai. Further introductions were made from Japan by Mrs. Dora Isenberg in 1905 and 1907, and by Mr. Richard Isenberg from Germany in 1905. These birds were all liberated on Kauai and are particularly common now about Kokee and in the Wainiha Valley. In 1928 and 1929 the Board of Agriculture and Forestry brought birds from Japan and freed them on Oahu, Maui, and Hawaii, and the Hui Manu added to the Oahu population in 1930 and 1931. It is not known with certainty what the status of the species is on the islands other than Kauai, but it is believed to be breeding on Oahu at least. It is hoped that this tit will eventually become established throughout the Territory.

Family TIMELIIDAE—Babbling Thrushes

Dryonastes chinensis (Scopoli). Black-throated or Peko Thrush

Length 11 inches, the sexes alike. General color above olive brown, the wings tinged with ashy gray; tail feathers tipped with black, and black on the outer webs; head and nape slaty blue; nasal plumes and base of forehead black, separated from the gray crown by a white frontal line; feathers around the eye, a streak above the ear, the ear coverts and hinder cheeks white; fore part of cheeks, throat, and fore neck black; breast and sides of fore neck ashy gray; abdomen olive brown; bill black; legs and feet dusky brown.

A native of the extreme south of China and Tonkin, ranging into Burma and Tenasserim. A few birds were sent from California in 1931 by Mr. Alexander Isenberg and liberated on Kauai. Nothing is known as to their present status.

Garrulax albogularis (Gould). Collared or Brown Thrush

Length 11½ inches, the sexes alike. General color above warm olive brown, the wings shaded with ashy brown; tail feathers ashy olive, all except the middle four broadly tipped with white; nasal plumes and feathers below the eyes black; a large dull orange rufous mark from the base of the forehead to above the eye; cheeks and throat white; a black spot at the base of the chin; fore-neck and chest olive brown, separating the white throat from the rest of the under surface, which is bright orange rufous; bare skin about the eye lead-colored; bill black; feet dull gray.

A native of the Himalaya region of northern India and Tibet. A few birds were imported from San Francisco in 1919 by Mrs. Dora Isenberg and liberated on Kauai, where they have become thoroughly established around Lihue.

Leiothrix lutea (Scopoli). Pekin Nightingale; Japanese Hill Robin

Length 6 inches. Male: the whole upper plumage dull olive green; throat and breast bright orange yellow; remainder of lower plumage mixed olive green and yellowish; a ring around the eye extending to the bill dull yellowish; edges of wing feathers brightly variegated with yellow, orange, crimson, and black; tail black, the hidden parts of the feathers olive brown; upper tail coverts extend two-thirds the length of the tail and terminate in a fine white line; bill orange red; legs and feet brown. The tail is slightly forked with the feathers curved outwards at the tip. Female: crown gray; no crimson on the wing; body plumage similar to the male but duller.

Native to Asia from the Himalaya region of India east to China and south to Siam, living in the hill forests, preferring the open type with secondary undergrowth. A lively little bird, with a very pleasing song, usually rather gregarious, and primarily an insect eater. Imported first in 1918 by Mrs. Dora Isenberg from San Francisco

and liberated on Kauai, and later, in 1928, by Mr. W. H. McNerny from San Francisco, and in 1928 and 1929 from the Orient by the Board of Agriculture and Forestry and private individuals. The birds in these later importations were liberated on Oahu, Maui, Kauai, Molokai, and Hawaii. The species occurs in rather large flocks on Kauai and is reported to be breeding on Molokai, Maui and Hawaii. It is believed to be breeding on Oahu, as birds answering to the description of the Pekin nightingale have been reported several times from widely separated localities.

Trochalopterus canorum (Linnaeus).

Chinese or Spectacled Thrush; Hwa-mei

Length about 8 to 9 inches, the sexes alike. Plumage a rather uniform reddish to olive brown; a white line around each eye and extending backward to the ear, forming a very good pair of spectacles; tail long and broad; bill yellow brown.

A native of the eastern Orient, and essentially a bird of the thickets and open woods, feeding on insects, berries, and so forth. It is a marvellous songster, performing to best advantage during a shower or on a cloudy day. This, the one real song bird that is thoroughly established in the islands, is an accidental escape from captivity. A favorite cage bird of the Chinese, a number obtained their freedom at the time of the great fire in the Oriental quarter of Honolulu in 1900, and took to the hills behind the city. The species is thoroughly established on Oahu. Later intentional introductions were made from the Orient to Maui, Molokai, and Hawaii. In 1918 birds were taken from Oahu to Kauai, and the species now seems to be well established on all the islands. It has been truly said that the establishment of the Chinese thrush was one of the most fortunate accidents that ever occurred in Hawaii.

Unidentified.

Oriental Thrush

Five individuals of an unidentified species of babbling thrush were purchased from a dealer aboard a Japanese liner in 1928 and liberated on Oahu. They have not been seen since, but it was hardly to be expected that an introduction so small would be effective. The birds were probably a species of *Trochalopterus* or *Dryonastes*, greatly resembling the *hwa-mei* but darker in color and lacking the white spectacles. There was a small dark blue patch immediately behind the eye.

Family MIMIDAE—Thrashers and Mocking Birds

Mimus polyglottos (Linnaeus).

Mocking Bird

Length about 10½ inches, the female somewhat smaller. Upper plumage grayish, in some individuals a brownish tint on the middle of the back; lower plumage whitish, slightly grayed on the breast; three outer pairs of tail feathers more or less white; rest of tail and wings blackish, the latter with two white bars and a large white patch; bill blackish, distinctly notched, and slightly curved at the tip.

A native of the southern United States and Mexico, the mocking bird is the most renowned songster in the Western Hemisphere. About 50 per cent of its food consists of vegetable matter, and oranges, grapes, figs, and small berries are taken; the remainder comprises insects of various kinds, principally grasshoppers, but also spiders, bollworm moths, and others. According to Dr. Henshaw, "It is unfortunate that it does not feed on injurious insects to an extent sufficient to offset its depredations on fruit." Since 1928 a number of these birds, imported from the mainland by private individuals, ostensibly as cage birds, have been intentionally liberated in Honolulu; from 1931 to 1933 numbers of them were brought in by the Hui Manu for liberation on Oahu, and in 1933 by the Hui Manu o Maui. It is not known whether or not they have attempted to nest.

Family TURDIDAE—Thrushes

Copsychus saularis prosthopellus Oberholser.

Magpie Robin; Dayal Bird

Length 8 inches. Male: head, neck, breast, and upper plumage glossy black; abdomen white to gray; a white line along the upper edge of the wing; outer pair of tail feathers white, the others glossy black; bill black; legs and feet dark gray. Female: the blue-black of the back is replaced by brownish gray; of the chin, breast, and throat by ashy gray.

The Chinese form of the well-known Indian species, essentially a bird of the groves. It dislikes open plains, dense forests, and heavy underbrush. Its food consists principally of such animal matter as grasshoppers, crickets, ants, beetles, earthworms, and the like, and a little vegetable material. A single pair was imported from Hong Kong by Mrs. D. R. Isenberg in 1922 and liberated on Kauai, and in 1932 the Hui Manu brought some from the same place for liberation on Oahu. They are not known to be breeding.

Horeites cantans cantans (Temminck and Schlegel).

Japanese Bush Warbler; Uguisu

Length $5\frac{1}{2}$ inches. Male: top of head and shoulders greenish; back and closed wing brown mottled with black; throat greenish yellow; breast yellow to buff; abdomen pale yellow; a narrow yellowish-white ring around the eye; bill slate-colored, short and rather heavy, sharp. Female: similar but duller in color; breast yellowish brown; in general, greenish to yellowish brown replaces the green of the male. In the young the green is replaced by brown.

An inconspicuous and rather sluggish bird, but a good songster and a voracious feeder on insects of many kinds. It is a native of Japan and essentially a bird of the forests. It was introduced in 1929 from Japan by the Board of Agriculture and Forestry and several times after that by the Hui Manu and by private individuals. All these birds were liberated on Oahu. They have been seen and heard on several occasions since, and they are thought to be breeding.

Kittacincla macroura (Gmelin).

Shama Thrush

Length 11 inches, the tail taking over half of this. Male: a patch above the base of the tail white; remainder of the upper plumage, wings, and lower plumage to the lower breast glossy black; remainder of lower plumage bright chestnut except for the whitish thighs; tail black, all except the four middle feathers broadly tipped with white; bill black; legs pale pinkish. Female: similar; the black is replaced by slaty brown and the chestnut by rufous; wing feathers narrowly edged with rufous.

A species widely distributed throughout India, Ceylon, China, Burma, Siam, and Malaysia. It inhabits forests with broken ravines and small hills, water, and open glades. It feeds mostly on the ground, on insects, worms, and fallen fruits. The shama is one of the famous song birds of India. A few birds brought from San Francisco by Mr. Alexander Isenberg in 1931 were liberated on Kauai. Nothing is known of their present status.

Luscinia akahige akahige (Temminck).

Japanese Red Robin; Komadori

Length about 6 inches. Male: top of head, back, and closed wing reddish olive; sides of head, neck, and throat bright red brown, the tail a trifle darker; breast gray, shading into white on the abdomen; a sharp semicircular black line separating the rufous and gray areas; bill medium long and slender; sharp, slate-colored. Female: similar but duller in color; the black line of demarcation on the breast absent, the rufous shading into the gray.

Native to Japan. A very quick and active little bird, darting over the ground in hedges and thickets, where it feeds on insects of all

kinds. It is a songster of no mean ability. First liberated on Oahu in 1929 by the Board of Agriculture and Forestry and later, in 1930 and 1931, by the Hui Manu. Although it can not be stated definitely that the species is established, it is thought that it will be.

Family MUSCICAPIDAE—Old World Flycatchers

* *Grallina picata* (Latham).

Magpie or Peewee Lark

Length 11 inches. Male: a line over the eye, a patch on each side of the neck, a longitudinal stripe on the wing, the tips of the secondaries, rump, and upper tail coverts, basal two-thirds and tips of the tail feathers, under surface of shoulder, breast, flanks, and abdomen white; remainder of plumage black, with a deep bluish tinge on the head, throat, chest, and back, and a greenish tinge on the wings and tail; bill ivory; feet black. Female: similar, but forehead, throat, and chin white.

A native of Australia, feeding solely on insects and their larvae, especially beetles and grasshoppers. The species was introduced from Australia by the Board of Agriculture and Forestry, first in 1922, then intermittently until 1929, and liberated on Oahu and Hawaii. It is believed to be established on both islands.

Muscicapa cyanomelana Temminck. Japanese Bluebird; O-ruri-cho

Length 6 inches. Male: head bright gleaming blue; back, rump, and closed wing duller blue; shoulders indigo; tail feathers white on the proximal half, the distal half black on the inner webs, blue on the outer; throat and breast black; abdomen white; bill black, medium long, blunt, the upper mandible slightly hooked. Female: head gray-brown with flecks of gleaming blue; upper back the same; rump dull blue; shoulders and closed wing bright blue; breast and throat brown; abdomen white.

A native of Japan and China, ranging as far south as Borneo, the bird is an excellent songster, and a typical flycatcher in its habits. It is slender in build and is given to perching still and erect, darting suddenly after its prey. The bird was introduced from Japan in 1929 by the Board of Agriculture and Forestry, and has been imported several times since by the Hui Manu and by private individuals, but in very small numbers, as the females are difficult to obtain. The birds were liberated on Oahu but their establishment is uncertain, although they have been seen several times since.

* *Rhipidura tricolor* (Vieillot).

Willie-wagtail; Black-and-white Fantail; Shepherd's Companion

Length 7 to 7½ inches, the sexes alike. Head, throat, back, and tail black; closed wing brown; sides cloudy gray; remainder of under surface white; a white streak above the eye; bill, legs, and feet brown.

A native of Australia and New Guinea, and a voracious feeder on insects. It is especially fond of following cattle and sheep, picking up the insects that accompany these animals, and of perching on the backs of cattle, feeding on horn flies and other parasitic insects. The species was imported from Australia in 1926 by the Board of Agriculture and Forestry and liberated on Oahu. It seems to have become established, especially in the dairying country at Waialae.

Family STURNIDAE—Starlings.

* *Acridotheres tristis* (Linnaeus).

Mynah

Length 9 inches, the sexes alike. Head, neck, and upper breast black; remainder of body plumage rich wine brown, darker above and paling into whitish on the lower abdomen; outer flight feathers dark brown, with a large white patch at the base; tail strongly rounded, blackish, all but the middle pair of feathers broadly tipped with white; bill, legs, and a fleshy wattle below and behind the eye yellow. In flight, a conspicuous white slash across the wings.

Native to India, the mynah is a perky, self-confident, pugnacious, and noisy bird, in many of its actions and antics disconcertingly human. It is gregarious, and the large flocks that gather at roosting time are most noisy and quarrelsome. It is omnivorous in its tastes, eating house scraps, fruit, grain, insects, and grubs of all kinds. In Hawaii it has been accused of many crimes and misdemeanors, from nest-robbing down, and is popularly supposed to have been a major factor in the extinction of many of the native birds. It is most unlikely that the latter charge can properly be laid at its door, however—neither the mynah nor the mongoose had much if any part in the calamity. The only authenticated account of nest-robbing by mynahs that I could find was made by Perkins in 1901. Other reports that I have been able to locate (Rothschild, W., *Avifauna of Laysan and the neighboring islands*, vol. 3, p. 300, London, 1900; Perkins, R. C. L., *Fauna Hawaiiensis*, vol. 1, pt. 4, p. 394, Cambridge, 1903; Henshaw, H. W., *Birds of the Hawaiian islands*, p. 130, Honolulu, 1902) boil down to indefinite accusations. Everything considered, although it must be admitted that the mynah can be and frequently is a nuisance, an impartial observer will be forced to

the conclusion that the bird's advantages to the islands are popularly decidedly underrated, while its disadvantages are overemphasized. It is without doubt of considerable value to the agriculturist. The species is reported to have been introduced from India in 1865 by Dr. William Hillebrand to combat the plague of army worms that was ravaging the pasture lands of the islands. It has spread and multiplied to an amazing extent; reported to be abundant in Honolulu in 1879, it is now extremely common throughout the Territory.

Family ZOSTEROPIDAE—White-Eyes.

Zosterops palpebrosus japonicus Temminck and Schlegel.

White-eye; Mejiro

Length about $4\frac{1}{2}$ inches, the sexes very similar. Top of head, back, rump, and closed wing olive green; throat yellow; breast and abdomen light brown and white; wing feathers dark, the outer edge olive; a conspicuous white ring around the eye; bill long and slender, very sharp, black.

This variety of a rather widely distributed Asiatic species is limited to Japan. It is a small active bird, an arboreal species which very rarely descends to the ground. It prefers hill jungles close to cultivation, where there is a good variety of plant life and consequently a good variety of food. It feeds on insects of many kinds, including ants and their larvae, as well as small buds, seeds, and wild fruits. The first introduction of record was made by the Board of Agriculture and Forestry, from Japan, in 1929, the birds being liberated on Oahu. There have been several later importations, by the Hui Manu and by private individuals, and the bird is known to be established on Oahu and possibly on Kauai.

Family DREPANIDIDAE—Hawaiian Honey-creepers.

Telespiza cantans Wilson.

Laysan Finch or Canary

Length about $6\frac{1}{2}$ inches, the sexes similar. Head, neck, and under parts to the lower abdomen rich yellow; upper parts brown, more or less washed with yellowish, and with or without dark streakings on the middle back; wing coverts brown, like the flight feathers margined with yellow; bill horny; legs and feet blackish.

Birds of this species, endemic to Laysan Island and now well established on Midway also, have been brought to Honolulu many times as pets, and some have made good their escape. They do not seem to find the conditions congenial, however, and have never persisted very long. They have considerable trouble with the mynahs.

Family PLOCEIDAE—Weaver-finches

Amandava amandava (Linnaeus).

Strawberry Finch

Length 4 inches. Male, in breeding plumage: the whole body plumage, except a black patch from the abdomen to under the tail crimson, more or less mottled with ashy brown; a patch above the base of the tail, and the sides of the neck, breast, and body spotted with white; wings brown, the part nearest the body speckled with white; tail blackish, the outer feathers white-tipped; bill short and conical, red, dusky about the nostrils; feet and legs brownish. At other seasons the plumage resembles that of the female, except that the throat and upper breast are grayer. Female: upper plumage brown; upper tail coverts dull crimson with minute white tips; wings and tail as in the male; a blackish mark in front of the eye; chin and throat whitish; sides of head and neck and the breast ashy brown; remainder of lower plumage saffron; flanks washed with ashy.

A native of south and southeastern Asia, from India to Java. A brightly colored, active little bird which frequents grasslands where the woods are not too far distant. It feeds mostly on the seeds of weeds and rank-growing grasses and may thus be rather beneficial economically, although it does feed to some extent upon rice grains in the milk. The strawberry finch is a justly popular cage bird. It is not known with certainty just when these birds came to Hawaii, but it was probably some time between 1900 and 1910. Many were imported as cage birds during this period and it is supposed that the present population is derived from individuals escaped from captivity. As far as is known, the species is restricted to the lowlands around Pearl Harbor, Oahu. It is not known to occur on any of the other islands and has not increased in numbers or extended its range on Oahu to any great extent.

* **Munia nisoria** (Temminck).

Ricebird

Length 4 inches. Male: upper plumage gray-brown with faint buff streaks; throat chestnut; breast gray flecked with chestnut; abdomen whitish; tail greenish gray faintly marked with brown; closed wing light chestnut; bill, legs, and feet blackish. Female: upper surface rather lighter in tone; under surface light buff.

A native of Malaysia which has been established in Hawaii for many years. The bird is said to have been brought in about 1865 by Dr. William Hillebrand. It feeds on the seeds of weeds and grasses and does considerable damage to green rice. It is found on all the islands but is not particularly common in districts where rice is not grown.

***Munia oryzivora* (Linnaeus).**

Java Sparrow

Length 6 inches, the sexes alike. Head and chin black; cheeks white; neck, back, closed wing, and breast gray; abdomen gray tinged with pinkish; rump and tail black; under tail coverts white; bill short, heavy, pinkish; legs and feet pink.

A native of Java and Malaysia, where it feeds upon weed and grass seeds, and to a very great extent upon green rice. It is a terrible pest to the rice growers, but a favorite with aviarists, who have developed a pure white form. A rather indefinite record that this species was introduced about 1865 by Dr. William Hillebrand exists. In the U. S. Department of Agriculture Technical Bulletin 61 there is a note to the effect that it was brought into Hawaii about 1900. It has, fortunately, failed to survive.

Family ICTERIDAE—Orioles, Meadow Larks, and Blackbirds

***Sturnella neglecta neglecta* Audubon.**

Western Meadow Lark

Length 8 to 10 inches. Male: upper mandible flattened on top, extending like a wedge into the feathers of the forehead; nostrils scaled; feathers of crown stiff and bristle-tipped; crown with a median buffy stripe between blackish stripes mixed with grayish brown; adjoining yellow and buffy lines over the eye and a narrow black streak behind the eye; rest of upper parts grayish brown streaked with black and buffy white and barred with black, especially on the wings and tail; under parts yellow, with a black crescent on the throat and dark streaks on the flanks, the yellow of the throat extending onto the cheeks; outer tail feathers mainly white. Female: similar but smaller and paler, with the yellow and black restricted.

A native of western North America from north-central British Columbia and southern Manitoba to southern Lower California. It is a wonderful songster. The bird feeds mostly on beetles, weevils, grasshoppers, crickets, cutworms, and other insects, but eats also some weed seeds and waste grain. It is a bird of great esthetic and economic value. The species was imported from California in 1931 by the Board of Agriculture and Forestry for liberation on Oahu, and by Mrs. Dora Isenberg for liberation on Kauai.

***Trochiloides militaris* (Linnaeus).**

Military Starling

Length 10 inches, the sexes similar. Upper plumage brown, especially on the head and back, variegated with black; in front of the eye red, behind it white, below it black; throat, middle of neck, breast, and upper belly scarlet; sides of belly with brownish edging to the black feathers; under wing coverts white; bend of wing red; bill horny; legs and feet brown.

A native of Falkland Islands, Chile, and Patagonia. A few individuals, obtained from a bird dealer in Washington, D. C., were liberated on Kauai in 1931 by Mr. Alexander Isenberg.

Family FRINGILLIDAE—Grosbeaks, Finches, and Buntings

*** *Carpodacus mexicanus frontalis* (Say).**

Linnet; House Finch; Papaya Bird

Length 5 to 5½ inches. Male: upper surface brownish gray; forehead and a stripe over the eye conspicuously red or pink, a faint pink wash over the back; rump red; throat and breast red; abdomen mottled gray and brown: closed wing brown, the feathers edged with gray; bill dark horny; legs and feet blackish. In a great many Hawaiian specimens the red or pink is replaced by orange or salmon pink. The effect of this is to give a chestnut tone to the back. Female: similar but lacking the red or yellow color, these areas being mottled in gray and brown.

A native of the western part of the United States, feeding principally on seeds of various weeds and grasses, and to some extent on fruits and green rice. Its local name, "papaya bird," is derived from its fondness for this fruit. This, however, is not an economic factor, as the bird takes only those fruits which have been allowed to become over-ripe on the tree and which are hence unfit for human consumption. The species was introduced into Hawaii many years ago, certainly prior to 1870, probably from San Francisco. It is probably an escape from captivity and is established, although it is nowhere particularly common, on the islands of Oahu, Hawaii, Lanai, Maui, and Kauai. In Hawaii the birds have run to orange and yellow types rather than to the pink or red, the predominating color types in California.

***Paroaria cucullata* (Latham).**

Brazilian Crested Cardinal

Length 7½ inches, the sexes alike. General color above ashy gray, the hind neck and upper mantle mottled with whitish; wings and tail dusky, the feathers edged with ashy gray; face, throat, fore-neck, and conspicuous crest scarlet; back of head and nape mottled like the hind neck; sides of neck and under surface white; bill gray; legs and feet black.

A brightly colored bird and an excellent songster, native to southern Brazil, Argentina, and Bolivia. The first introduction was made in 1928, the birds being purchased from a dealer in San Francisco and liberated on Oahu by Mr. William McInerny. Later importations, brought from Brazil to order by a mainland dealer, were

made by Mr. McInerney and the Hui Manu in 1928, 1929, 1930, and 1931. The birds were all freed on Oahu. They are known to be breeding and have been seen in many places on the island. The species bids fair to become well established.

Paroaria larvata (Boddaert).

Pope Cardinal

Length 7 inches, the sexes alike. General color above dark gray, the hind neck mottled with whitish; wings and tail almost black, the feathers edged with white; crown with a slight crest, crimson, as are the face and throat, this color extending as a tab onto the upper breast; sides of neck and under parts white; bill gray; legs and feet black. The pope cardinal differs from the Brazilian crested cardinal chiefly in the almost complete absence of the crest, in the lesser amount of red on the breast, and in the generally darker color of the back and wings.

A bright-colored songster, native to Brazil. The only introduction of record was made on Oahu in 1931 by the Hui Manu. The birds were included in a shipment of the crested cardinal (*P. cucullata*), which they closely resemble, and freed along with them. Unfortunately, they have not been seen since.

*** Passer domesticus** (Linnaeus).

English Sparrow

Length about 6½ inches. Male: above reddish brown, the back streaked with black; crown and under parts brownish ash, chin and throat black; a white wing bar; a large patch of chestnut on each side of the head, starting above and behind the eyes and extending back to the sides of the neck; lesser wing coverts bright chestnut; bill black; eye, legs, and feet brown. Female: duller colored and lacking the black on chin and throat; a pale brown stripe behind the eye; bill dark brown, the lower mandible yellowish at the base.

A native of western Europe, now thoroughly naturalized throughout the United States. On the mainland the bird is a decided pest because of its habit of feeding on grain, fruits, and garden truck, often destroying much more than it actually eats, and because of its pugnacious proclivities, whereby it has driven many of the native birds away from the inhabited districts. In Hawaii it is, if anything, rather useful. It is recorded that nine English sparrows were brought in from New Zealand in 1871 and liberated in Honolulu. Whether or not there were further importations is not known, but the species was reported to be numerous in Honolulu in 1879. The sparrow has not multiplied nearly so rapidly as it did on the mainland; although it occurs on all the Hawaiian islands it is not at all common except on Oahu, where it attained its first foothold.

Richmondena cardinalis (Linnaeus).

Kentucky Cardinal

Length 8 inches. Male: top of head and crest, breast, and abdomen cardinal red; back duller red mixed with gray; closed wing and tail dull reddish; a square black area around the bill, including the eyes; bill strong, heavy, orange red; tail long and broad. Female: breast and abdomen bright buff; head and back gray; crest, closed wing, and tail dull red; the black area about the bill absent.

A native of the eastern United States, north to New Jersey, southern Pennsylvania, and the Ohio Valley, west to the plains. The bird feeds on the seeds of numerous plants, chiefly those of rank-growing weeds and grasses, and grain is sometimes taken. It feeds more or less on insects, mainly beetles, grasshoppers, crickets, ants, flies, and numerous larval forms. Ornithologists of the U. S. Bureau of Biological Survey have stated that the cardinal does at least 15 times as much good as harm—a record of which any animal, man included, could well be proud. The first introduction was made in 1929, when one of a pair of cardinals that was being held for observation escaped. Its mate was later liberated. Although these birds gained their liberty in Honolulu several days apart, they were seen together some time later near Waialua. During the same year a number of birds were brought from the mainland by Mr. William McInerny and liberated on Oahu, as were birds imported by the Hui Manu in 1931. In 1929 and 1930 several hundred individuals were imported by the Chamber of Commerce of Hilo, having been purchased with funds raised by private subscription, and liberated in and around Hilo. Mrs. Dora Isenberg liberated some on Kauai in 1929 also. The birds are known to be breeding on Oahu and Hawaii, but I do not know their status on Kauai.

Serinus serinus canaria (Linnaeus).

Canary

Length 4½ inches, the sexes alike. This bird is too well known to need description, and moreover the almost innumerable color varieties make a description well-nigh impossible. They are generally yellow, at least as to base color, ranging from white or pale cream to orange, and may be marked with cinnamon, brown, greenish, or black, or combinations of these colors.

A native originally of Madeira, the Canary Islands, and the Azores, the bird could almost be considered a native of captivity. It is certainly the commonest and best known of the many species of cage birds. Individuals have escaped in Hawaii many times, but the competition, after their many generations in captivity, seems to be too great for them. In any event, the fugitives do not last long,

although on Midway Island, where several pairs were liberated about 1912, they have become well established.

Unidentified.

Grosbeak

According to the report of the Board of Commissioners of Agriculture and Forestry for 1902, grosbeaks were liberated early in that year by Mr. E. P. Low at Puuwaawaa, Hawaii. They evidently did not survive.

SUMMARY OF THE TERRITORIAL STATUTES
RELATING TO BIRDS

Section 603, R. L. H. 1925, as amended by Act 54, S. L. 1927, specifies the conditions under which birds may be imported.

Section 731, R. L. H. 1925, as amended by Act 87, S. L. 1927, names the closed seasons on certain game birds, and specifically prohibits the molestation of skylarks at any time.

Section 732, R. L. H. 1925, as amended by Act 134, S. L. 1931, prohibits, except as otherwise provided, the killing, selling or offering for sale of birds of any species except the mynah imported for the purpose of establishing the species in Hawaii.

Section 732A, added by Act 134, S. L. 1931, defines prima facie evidence of the violation of Section 732.

Section 733, R. L. H. 1925, excepts from the above provisions any species declared to be a common nuisance.

Sections 734-737, R. L. H. 1925 (Section 735 as amended by Act 134, S. L. 1931), prohibit the molestation of Hawaiian geese and all passerine birds other than the English sparrow, linnet, ricebird, mynah and any other species declared injurious to agriculture or forestry, except under permit.

Sections 738-741, R. L. H. 1925, define the conditions under which such permits may be issued.

Section 742, R. L. H. 1925, sets aside certain small islets as animal and bird reservations.

Sections 744-745, R. L. H. 1925, relate to the ownership and hunting of wild birds on private lands.

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POLYNESIAN MOSSES

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INTRODUCTION

During the past ten years or so Bernice P. Bishop Museum has accumulated quite a representative series of moss collections from various parts of Polynesia. The list is an interesting one, and though it presents a suggestive bird's eye view of the mosses of this extensive region it is necessarily still incomplete. Only a relatively small number of species has as yet been collected in the Marquesas Islands, and the numberless small groups and isolated islands that have never been explored bryologically are legion.

The extensive collections of E. H. Quayle, in association with the Whitney Expedition in 1921-1922, from the Society Islands and other groups are nicely supplemented by smaller gatherings made by J. F. G. and A. M. Stokes in the Austral Islands; W. B. Jones, Mrs. G. P. Wilder, and K. P. Emory in the Tuamotu Archipelago; E. P. Mumford, W. B. Jones, and F. B. H. and E. D. W. Brown in the Marquesas Islands, together with a small collection from the Cook Islands and Tonga by H. E. and S. T. Parks and W. A. Setchell which came from the University of California.

A complete series of the mosses listed below, along with the types of the new species, has been deposited in Bernice P. Bishop Museum. A duplicate series remains in the herbarium of the writer.

AUSTRAL ISLANDS

Campylopus introflexus (Hedwig) Bridel.

Rapa, Whitney Expedition, 1921?.

Campylopus umbellatus (Walker-Arnott) Bartram.

Rapa, Lekie, top of peak, elevation 1150 feet, September 23, 1921, J. F. G. Stokes No. 234; Rapa, Nukumaala, on rock face of cliff, by waterfall, elevation 200 feet, September 21, 1921, A. M. Stokes no. 266.

Dicranoloma plicatum new species (fig. 1).

Robustum. Caulis ad 6 cm. altus, ramosus. Folia conferta, nitida, 7-8 mm. longa, oblongo-lanceolata, plicata; marginibus hyalino-limbatus, prope apicem argute dentatis; costa valida, percurrent; cellulae alares magnae, ex laminae inferiores elongatae, incrassatae, valde porosae, superne sensim breviores, in subula breves, ovals, laeves, incrassatae, hic illic bistratoses, marginales plus minusve elongates. Caetera ignota.

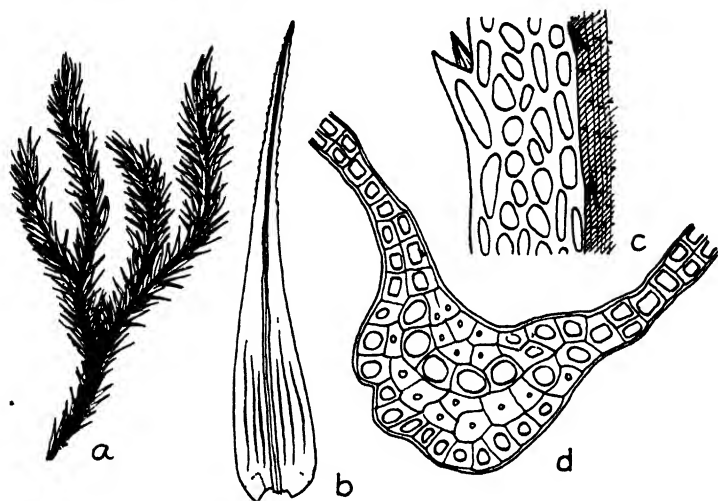


FIGURE 1.—*Dicranoloma plicatum* Bartram: a, plant, $\times .9$; b, leaf, $\times 9$; c, upper leaf cells and margin, $\times 377.5$; d, cross section of costa from upper part of leaf, $\times 377.5$.

Robust, densely tufted plants, yellowish brown and glossy above, deep brown below. Stems up to 6 cm. high, branched, densely tomentose. Leaves crowded, flexuose-spreading and somewhat crisped when dry, erect-spreading when moist, oblong-lanceolate, carinate, strongly plicate below, 7-8 mm. long, gradually narrowed to a stout, grooved point, bordered with a narrow band of elongated, colorless cells in the median portion, which merges with the basal cells below and disappears some distance below the apex; margin erect, entire below, sharply toothed above, the teeth frequently in pairs; costa about 75μ wide near the base, percurrent or slightly excurrent, toothed on the back above, in cross-section showing bands of stereid cells on both sides of the median guide row with the surface layer on the dorsal side differentiated; alar cells conspicuous, reddish brown, extending more than halfway to the costa, basal cells linear, porose, incrassate, gradually becoming shorter upward, the upper cells short, smooth, incrassate, irregular in shape, oval and oval-rhomboidal, frequently bistratose in spots, $7-10\mu$ wide by 1-1.5 times as long.

Rapa, Whitney Expedition 1921? (type); Rapa, with fern (*Hymenophyllum cuneatum*), E. H. Quayle, 1921?.

A very beautiful moss which resembles *D. dicarpum* (Hornschuch), of Australia and New Zealand, in some respects but is notably different in the more numerous plicae of the leaf base, the less strongly serrate leaf margins with the teeth often in pairs and the different areolation of the upper part of the leaf in which the cells are often bistratose.

Philonotis Vescoana Bescherele.

Rapa, Whitney Expedition, 1921 ?.

Spiridens Balfourianus Greville.

Rapa, with fern (*Loxoscapha gibberosum*), E. H. Quayle, 1921 ?; Rapa, Whitney Expedition, 1921 ?.

Rhacopilum convolutaceum C. Müller.

Raivavae ?, Whitney Expedition, 1921 ?, no. 393 ; Raivavae, 1921 ?, A. M. Stokes ?.

Papillaria Aongstroemiana C. Müller.

Rapa, Mitieperu, on platform among grass, elevation 1175 feet. October 26, 1921, J. F. G. Stokes with 373 ; Raivavae, Whitney Expedition, 1921, no. 393 ?.

Neckeropsis Lepineana (Montagne) Fleischer.

Rapa, Maitua, on rocks under trees, elevation 575 feet, October 10, 1921, A. M. Stokes no. 318. Native name, *limulimu*.

Entodon Solanderi (Aongstrom) Jaeger.

Rapa, Maitua, on rocks under trees, elevation 575 feet, October 10, 1921, A. M. Stokes no. 318a.

Sematophyllum hawaiiense (Brotherus) Brotherus.

Rapa, Whitney Expedition, 1921 ?, (with lichen) no. 386 ; Raivavae, Whitney Expedition, 1921 ?, no. 392.

Ectropothecium sandwicense (Hooker and Walker-Arnott) Mitten.

Raivavae ?, Whitney Expedition, 1921 ?.

Taxithelium Vernieri (Duby) Bescherele.

Raivavae ?, Whitney Expedition, 1921 ?.

TUAMOTU ARCHIPELAGO

Leucobryum scalare C. Müller, form.

Makatea, interior on log, August 18, 1922, Whitney Expedition no. 874.

These plants represent a slender form approaching the variety *Marschmeyeri* Fleischer but with narrower more erect leaves up to 3 mm. long.

Leucophanes nukahivense Bescherele.

Makatea, on ground, elevation 200 feet, October, 1932, Mrs. G. P. Wilder no. 101; Makatea, on ground, elevation 250 feet, October 24, 1932, Mrs. G. P. Wilder no. 102.

Syrrhopodon Banksii C. Müller.

Makatea, growing on fallen tree trunk, elevation 175 feet, October 27, 1932, Mrs. G. P. Wilder no. 107.

Thyridium obtusifolium (Lindberg) Fleischer.

Pitcairn Island, Whitney Expedition 1922?; Henderson Island, with fern (*Polypodium diversifolium*), E. H. Quayle 1922?.

Calymperes tenerum C. Müller.

Mangareva (with lichen), April 27, 1922, E. H. Quayle no. 424; Tikei (with lichen), August 31, 1922, W. B. Jones no. 1049a; Ahii, interior on dead and living trees, August 26, 1919, W. B. Jones no. 952a; Makatea, on rotten *Pandanus* log, elevation 100 m., August 18, 1922, W. B. Jones no. 867; Makatea, interior, jungle, elevation 100 m., August 18, 1922, W. B. Jones no. 862; Makatea, on coconut trunk, elevation 200 feet, Mrs. G. P. Wilder no. 108.

Calymperes tuamotuense new species (fig. 2).

C. Aongstroemii Bescherele *persimilis*, foliis autem *incrassato-limbatis*.

Densely tufted plants, yellowish green above, brown below. Stems simple or branched, from a few millimeters to 3 cm. high. Normal leaves erect with incurved points when dry, erect-spreading when moist, ligulate from a slightly broader ovate base, concave, obtuse or rounded at the apex, 3 mm. long; margin thickened, erect or incurved, denticulate; costa stout, about 60μ wide toward the base, ending just below the apex, scabrous on the back to the top of the leaf base; leaf cells $5-6\mu$ in diameter, hexagonal, dense, mamillate on the ventral side, minutely papillose on the back, 4-5 rows at the margins in several layers forming a distinct thickened border extending from just below the apex to the top of the cancellinae, teniolae none, cancellinae scalariform, usually ending in acute angles above, 5-6 rows of cells toward the margins of the

leaf base linear-oblong, smooth; margins sharply denticulate at the top of the leaf base, denticulate above. Abnormal leaves about 4 mm. long, with a stouter costa and narrower lamina.

Ahii, interior on dead and living trees, August 26, 1919, W. B. Jones no. 952 (type); Makatea, interior on rotten *Pandanus* log, August 18, 1922, W. B. Jones no. 867; Makatea, interior on living tree in jungle, elevation 100 m., August 18, 1922, W. B. Jones no. 864; Makatea, March 3, 1930, K. P. Emory; Manihi, Whitney Expedition, February 10, 1923, no. 1929; Faite, April 26, 1923, Whitney Expedition no. 2037.

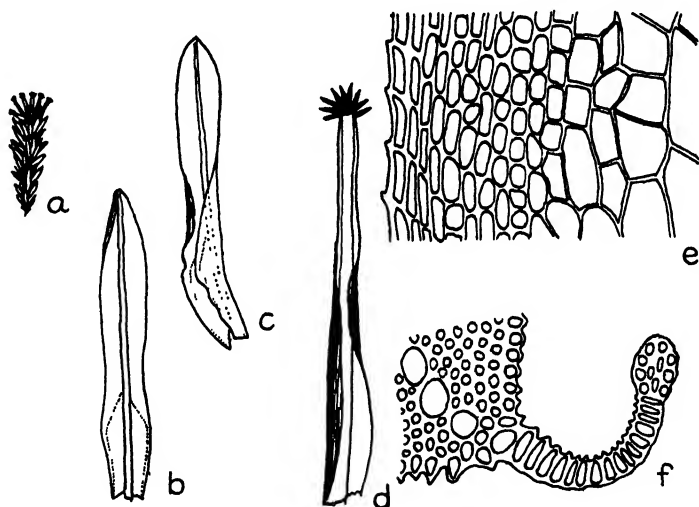


FIGURE 2.—*Calymperes tuamotuense* Bartram: a, moist plant, $\times .9$; b-c, normal leaves, $\times 13.5$; d, abnormal leaf, $\times 13.5$; e, part of upper leaf base and margin, $\times 377.5$; f, one side of cross section of leaf, $\times 377.5$.

The thickened leaf border clearly separates this species from *C. Aongstroemii* Bescherelle.

***Calymperes pseudopodianum* new species (fig. 3).**

Caulis ad 2 cm. altus. Folia ligulata, concava, apiculata, 3-3.5 mm. longa; marginibus denticulatis; costa percurrente, dorso papilloso-tuberculata, cellulis hexagonis, mamillosis, cancellina superne rotundata haud scalariformi, margines versus angustatis, teniola angusta, in lamina ad medium producta.

Stems up to 2 cm. high, usually branched. Leaves erect, incurved and slightly crispate when dry, erect-spreading when moist, broadly ligulate from a short, scarcely wider base, concave, apiculate, 3-3.5 mm. long, margins erect,

denticulate except at the extreme base; costa about 90μ wide below, percurrent, densely papillose-tuberculate on the back to below the top of the leaf base, papillose on the inner side; leaf cells $6-8\mu$ in diameter, rounded-hexagonal, sharply mamilllose on both sides, in one layer throughout, teniolae distinct, about 4 rows in from the margin at the top of the leaf base and extending more than halfway up the blade, 2 rows wide below and 1 row wide above, cancellinae in about 8 rows, rounded or ending in blunt angles above. Abnormal leaves up to 4 mm. long with a thicker costa and a very narrow lamina, which is frequently reduced to a scarcely evident wing on either side.

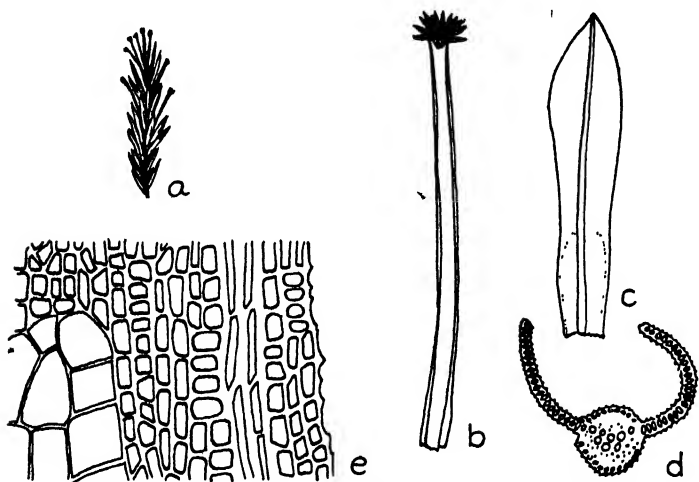


FIGURE 3.—*Calymperes pseudopodianum* Bartram: a, moist plant, $\times .9$; b, abnormal leaf, $\times 13.5$; c, normal leaf, $\times 13.5$; d, cross section of leaf, $\times 112.5$; e, cells and margin at top of leaf base, $\times 377.5$.

Makatea, March 3, 1930, K. P. Emory (type); Makatea, interior on rotten log, elevation 100 m., August 18, 1922, W. B. Jones no. 877.

The well-marked teniolae and unbordered leaves will distinguish these plants from *C. tuamotuense*. A suggestive resemblance to the pseudopodia of *Aulacomnium androgynum* will be noted in the abnormal leaves which are frequently reduced to an almost naked costa with dense apical clusters of propagula.

***Brachymenium melanothecium* (C. Müller) Jaeger.**

Makatea, on rocks, elevation 300 feet, October 21, 1932, Mrs. G. P. Wilder no. 103; Rangiroa, north side, base of living tree, August 22, 1922, W. B. Jones no. 936.

Macromitrium subuligerum (Bry. Jav.) Fleischer.

Makatea, growing on fallen tree trunks, elevation 175 feet, October 27, 1932, Mrs. G. P. Wilder no. 104; Makatea, interior on living tree, August 18, 1922, W. B. Jones no. 866.

Rhacopilum cuspidigerum (Schwaegrichen) Mitten.

Mangareva, April 27, 1922, E. H. Quayle no. 422.

Papillaria Aongstroemiana C. Müller.

Mangareva, April 27, 1922, E. H. Quayle no. 423.

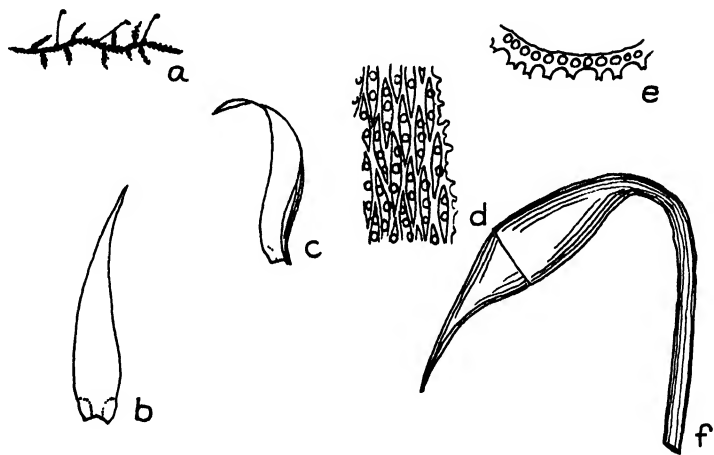
Trichosteleum pygmaeum new species (fig. 4).

FIGURE 4.—*Trichosteleum pygmaeum* Bartram: a, plant, $\times .9$; b-c, leaves, $\times 25.5$; d, upper leaf cells and margin, $\times 377.5$; e, cross section of leaf cells, $\times 377.5$; f, capsule and upper part of seta, $\times 25.5$.

Autoicum. Caulis 2-3 cm. longis, ramis brevis, erectiusculis. Folia conferta, subsecunda, ovato-lanceolata, acuminata, concava, ecostata; cellulis superioribus fusiformibus, dorso grosse seriatim papillois, inferioribus hyalinis, laevis, alaribus tribus, vesiculaeformibus. Seta 5-6 mm. longa, rubra, fere laevis; theca minuta, ad 0.5 mm. longa, horizontalis, ovato-cylindrica.

Autoicum. Small plants growing in dense mats, golden yellow, not at all glossy. Stems prostrate, irregularly branched, branches short, stout, erect or ascending. Leaves crowded, slightly falcate-secund, ovate-lanceolate, acuminate, concave, ecostate, 1-1.2 mm. long; margins erect, denticulate above and coarsely papillose-crenulate all around; upper leaf cells elliptic-rhomboidal with 2-4 large, capitate papillae over the lumens on the dorsal side, more elongate below, linear, slightly porose and usually smooth at the extreme base. Seta 5-6 mm. long, red, hooked at the tip, smooth throughout or very slightly

scabrous at the top; capsule horizontal, ovoid-cylindric, up to 0.5 mm. long; lid needle-like, longer than the urn.

Makatea, August 18, 1922, W. B. Jones no. 867a (type); Makatea, on rotten log in jungle, elevation 100 m., August 18, 1922, W. B. Jones no. 877a.

Resembling *T. hamatum* (Dozy and Molkenboer) but much smaller in every way. The very short, nearly smooth setae, minute capsules, and shorter upper leaf cells obscured by the coarse, capitate papillae seem amply to distinguish this species from any of the familiar forms of *T. hamatum*.

Taxithelium Vernieri (Duby) Bescherele.

Makatea, interior on rotten log, elevation 100 m., August 18, 1922, W. B. Jones no. 877b.

Ectropothecium sandwicense (Hooker & Walker-Arnott) Mitten.

Makatea, on rocks, elevation 300 feet, October 21, 1932, Mrs. G. P. Wilder no. 105; Makatea, on coral stone, elevation 250 feet, October 24, 1932, Mrs. G. P. Wilder no. 106.

MARQUESAS ISLANDS

Dicranella rufiseta new species (fig. 5).

Dioica? Gracilis, caespitibus densis, haud nitidis. Folia sicca erecta, ovato-lanceolata; marginibus paulum revolutis, summo apice obtuse denticulato; costa valida, percurrentes vel excurrentes; cellulis rectangularibus, incrassatis, basilariibus longioribus. Seta ad 10 mm. alta, lutescenti-rubra; capsula erecta, ovali-oblonga; annulus latus; peristomii dentibus rubris, ultra medium bifidis, circa 250 μ longis; operculum longe et oblique rostratum; spori 18-20 μ , punctulati.

Dioicous? Slender, densely tufted plants, dull yellowish green above, brown below. Stems erect, easily separating, scarcely radiculose below, 1-2 cm. high. Leaves well-spaced below, crowded and longer at the tips of the stems, up to 2.5 mm. long, from a short oblong or ovate base gradually narrowed to a straight, grooved point which is blunt and denticulate at the apex; margin denticulate at the apex, otherwise entire, often narrowly reflexed near the shoulders of the leaf; costa stout, yellowish, 75 μ wide below, percurrent or slightly excurrent; lower leaf cells narrowly rectangular and linear with firm, pellucid walls, gradually shorter and rectangular upward. Seta 7-10 mm. long, slender, bright orange red; capsule erect, cylindric, urn 0.8-1 mm. long, brown when young, becoming dark brown or blackish with age; peristome teeth pale red, about 250 μ high, cleft to about the middle, papillose-striate; lid oblique, subulate-rostrate, as long as the urn; annulus broad; spores papillose, 18-20 μ in diameter.

Type: Nukuhiva, 1922?, E. H. Quayle no. 1253.

Although this species is closely allied to *D. hawaïica* (C. Müller) Brotherus, it is perfectly distinct in the much shorter and less flexuose leaves which are more gradually narrowed to a rigid, blunt point and, especially, by the orange-red setae.

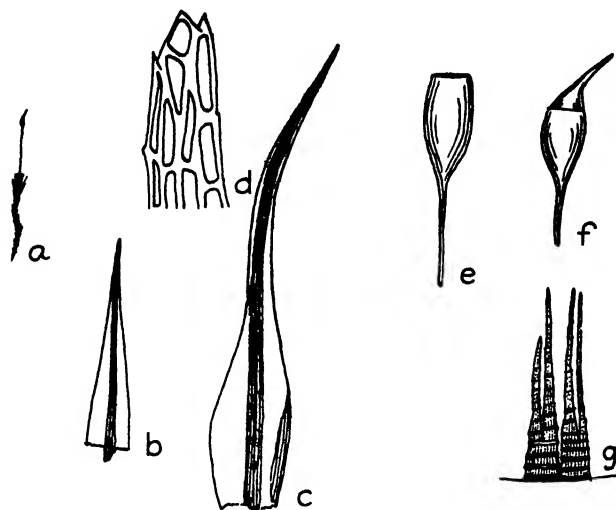


FIGURE 5.—*Dicranella rufiseta* Bartram: a, plant, $\times .9$; b, lower leaf, $\times 25.5$; c, comal leaf, $\times 25.5$; d, apex of leaf, $\times 377.5$; e, old capsule, $\times 9$; f, young capsule with lid, $\times 9$; g, 2 peristome teeth, $\times 120$.

***Dicranoloma ruffolium* (Bescherelle) Paris.**

Hivaoa, Tapeata, east of Mount Ootua, elevation about 700 m., May 8, 1929, E. P. Mumford and A. M. Adamson, no. 378; Uapou, elevation 1200 m., with fern (*Oleandra whitmeei* variety *minor*), September 9, 1922, E. H. Quayle no. 1145; Uapou, Mount Tekahoipu, elevation 1050 m., with filmy fern, E. H. Quayle no. 1156.

***Dicranoloma brevifolium* new species (fig. 6).**

Robustum. Caulis ad 7 cm. altus, parce ramosus. Folia conferta, secunda, nitida, 5-6 mm. longa, ovato-lanceolata; marginibus fere ad basin denticulatis, superne grosse serratis; costa valida, percurrentes vel breviter excurrentes, dorso valde prominens, per partem superiorem folii seriebus duabus argute grosse spinoso-dentata; cellulae alares magnae, ex laminae inferiores elongatae, valde porosae, superiores elongatae vel perbreves, rectangulares, parietibus incrassatis, vix porosae.

Robust plants, golden brown above, deep brown below. Stems up to 7 cm. high, usually sparsely branched, tomentose throughout. Leaves crowded, fal-

cate-second, 5-6 mm. long, from an ovate-lanceolate base gradually narrowed to a linear, grooved point; margins erect, coarsely serrate in the upper half, denticulate almost or quite to the base; costa strong, 90μ wide at the base, percurrent or very shortly excurrent, prominently convex on the dorsal side and with two sharply serrate lamellae on the back in the upper half; alar cells large, brownish, extending halfway to the costa, basal cells linear, incrassate, strongly porose, upper cells rectangular and linear with rounded ends, $5-6\mu$ wide by 2-4 times as long, incrassate.

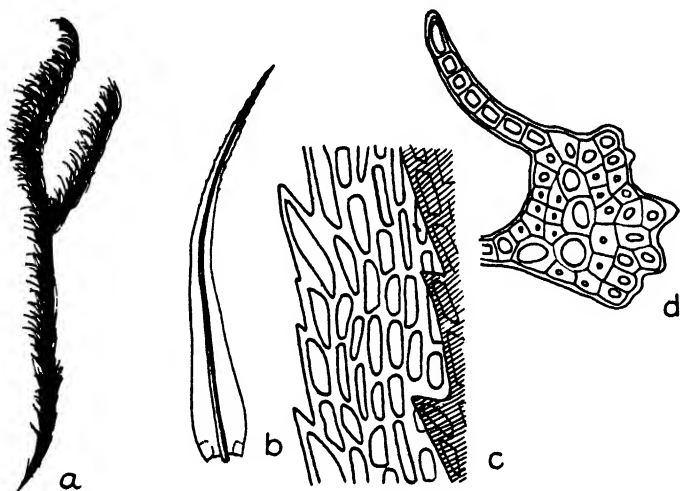


FIGURE 6.—*Dicranoloma brevifolium* Bartram: a, plant, $\times .9$; b, leaf, $\times 9$; c, upper leaf cells, $\times 377.5$; d, cross section of costa from upper half of leaf, $\times 377.5$.

Nukuhiva, cool, shaded, moist conditions on *Hibiscus tiliaceus*, cloud zone, elevation 1000 m., July 20, 1921, F. B. H. and E. D. W. Brown no. 537 (type); Nukuhiva, with *Tmesipteris tannensis*, 1922?, E. H. Quayle no. 1305; Nukuhiva, with *Hymenophyllum cuneatum* variety *calyciforme*, September, 1922, E. H. Quayle no. 1305a.

Immediately distinguished from *D. rufifolium* by the shorter leaves with the costa percurrent or barely excurrent and by the shorter areolation of the subula. It is probably nearest *D. platycaulon* (C. Müller) Dixon, but the leaves are shorter and the upper leaf cells more regularly elongate and incrassate.

***Leucophanes nukahivense* Bescherelle.**

Uapou, elevation 350 m., September 7, 1922, W. B. Jones no. 1107, in fruit; Uapou, Mount Tikahoipu, September 11-13, 1922,

E. H. Quayle no. 1179; Nukuhiva, Tovii, elevation 1000 m., at base of fern (*Hymenolepis spicata*), June 1, 1921, F. B. H. and E. D. W. Brown no. 463; Uahuka, Hannay, high ridge, elevation 700 m., November 10, 1922, W. B. Jones no. 1685.

Thyridium obtusifolium (Lindberg) Fleischer.

Nukuhiva, east slope ridge, elevation 3500 feet, 1922?, E. H. Quayle no. 1223; Nukuhiva, 1922?, E. H. Quayle no. 1280; Uapou, Mount Tikahoipu, September 11-13, 1922, E. H. Quayle no. 1179.

Calymperes Aongstroemii Bescherelle.

Eiao, interior of furas forest, high ridge, elevation 700 m., September 20, 1922, W. B. Jones no. 1522.

Calymperes Vriesei Bescherelle.

Nukuhiva, Taiohae (region), elevation 500 m., at base of fern (*Hymenolepis spicata*), June 1, 1921, F. B. H. and E. D. W. Brown no. 463h.

This is a wide extension of the geographical range of the species, but the plants from Nukuhiva agree very well with authentic specimens from Java.

Philonotis Vescoana (Bescherelle) Brotherus.

Nukuhiva, 1922, E. H. Quayle nos. 1268 and 1325.

Hypondendron Vescoanum Bescherelle.

Nukuhiva, Tovii, elevation 600 m., with fern (*Trichomanes pyxidiferum* variety *marchionicum*), October 1, 1921, F. B. H. and E. D. W. Brown no. 614.

Mniodendron tahiticum Bescherelle.

Uapou, top of high ridge, elevation 1200 m., with ferns (*Polypodium hookeri* variety *uapense*), W. B. Jones no. 1210.

Macromitrium eurymitrium Bescherelle.

Nukuhiva, cool, shaded, moist condition, on *Hibiscus tiliaceus*, cloud zone, 1000 m., E. D. W. and F. B. H. Brown, July 20, 1921, no. 537.

Rhacopilum convolutaceum C. Müller.

Nukuhiva, 1922?, E. H. Quayle, nos. 1220, 1251; Nukuhiva, cool, shaded, moist conditions, on *Hibiscus tiliaceus*, cloud zone, elevation

1000 m., F. B. H. and E. D. W. Brown no. 537; Uapou, high ridge, elevation 900 feet, September 12, 1922, W. B. Jones no. 1178.

Ptychomnium aciculare (Bridel) Mitten.

Uapou, high ridge, elevation 900 m., September 12, 1922, W. B. Jones no. 1178; Hivaoa, Feani, elevation 900 m., at base of fern (*Oleandra whitmei*), December, 1921, F. B. H. and E. D. W. Brown no. 980; Hivaoa, elevation 1000 m., on rhizome of fern, December, 1921, F. B. H. and E. D. W. Brown no. 1102.

Garovaglia Powellii Mitten.

Nukuhiva, 1922?, E. H. Quayle no. 1280.

These plants show the characteristic teeth on the dorsal ridges of the leaf plicae and agree perfectly with the type collection from Samoa. The species may be looked for in the Society Islands.

Papillaria helictophylla (Montagne) Brotherus.

Uapou, Mount Tikahoipu, with *Selaginella*, September 11-13, 1922, W. B. Jones no. 1178; Uapou, high ridge, elevation 900 m., September 12, 1922, W. B. Jones no. 1178.

Papillaria Aongstroemiana C. Müller.

Nukuhiva, elevation 800? m., at base of fern, (*Hymenolepis spicata*), 1922, E. H. Quayle no. 1217.

Acroporium Lepinei (Bescherelle) Fleischer.

Nukuhiva, 1922?, E. H. Quayle no. 1280.

Taxithelium falcifolium new species (fig. 7).

Autoicum. Lutescent-viride, nitidum. Caulis fragilis, ad 3 cm. longis, irregulariter pinnatis, ramis flexuosis, ad apicem uncinatis. Folia subfalcata, vix complanata, circa 1.2 mm. longa, e basi contracta, ovato-lanceolata, concava, ecostata; marginibus erectis, papilloso-crenatis, superne minute denticulatis; cellulae elongatae, lineares, parietibus tenuibus, distincte pluripapillatae, ad insertionem breviores parietibus incrassatis, alares 2-4, parum latiores. Folia perichaetialia in subulam minute denticulatum attenuata; seta circa 10 mm. longa, laevis; theca minuta, inclinata, 0.9 mm. longa.

Autoicous. In very dense extensive mats, pale yellowish green, glossy. Stems fragile, prostrate, irregularly pinnate, branches ascending, flexuose, hooked at the tips. Leaves falcate-secund, about 1.2 mm. long, ovate-lanceolate, acuminate, concave, contracted above the insertion, ecostate; margin erect, papillose-crenulate, minutely denticulate above; leaf cells linear, slightly vermicular, 3-4 μ wide by 10-14 times as long, thin-walled, seriate papillose with 3-5 distinct papillae over the lumens, several rows across the insertion shorter,

broad, smooth, slightly porose, alar cells few, 2-4, subquadrate, not well defined. Inner perichaetial leaves about 1.6 mm. long, narrowly lanceolate, gradually narrowed to a long, denticulate, subulate point; seta slender, smooth, reddish, about 10 mm. long; capsule inclined, ovoid, urn 0.7 mm. long; spores smooth, 12-14 μ in diameter.

Type: Eiao, interior of furas forest, high ridge, elevation 700 m., September 20, 1922, W. B. Jones no. 1522.

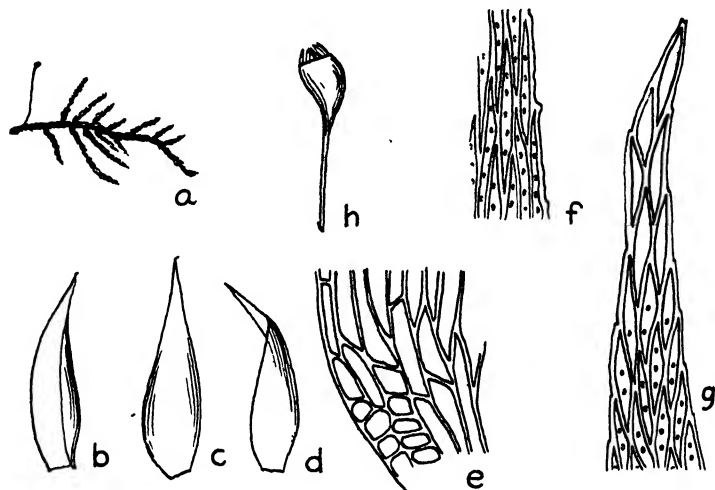


FIGURE 7.—*Taxithelium falcifolium* Bartram: a, plant, $\times .9$; b-d, leaves, $\times 25.5$; e, basal angle of leaf, $\times 377.5$; f, upper leaf cells and margin, $\times 377.5$; g, apex of leaf, $\times 377.5$; h, capsule, $\times 9$.

The crowded, falcate-secund leaves, relatively short-pointed and hooked at the tips of the branches, distinguish this species from *T. Vernieri* (Duby) Bescherelle.

In comparison with *T. Lindbergii* the leaves of *T. falcifolium* are broader, less slenderly acuminate and less sharply toothed on the apical margins.

Ectropothecium sodale (Sullivant) Mitten.

Nukuhiva, 1922?, E. H. Quayle nos. 1220, 1245, 1251, 1268; Nukuhiva, cool, shaded, moist conditions, on *Hibiscus tiliaceus*, cloud zone, elevation 1000 m., F. B. H. and E. D. W. Brown no. 537; Uapou, side of ridge, on living trees, elevation 400 m., September 13, 1922, W. B. Jones no. 1197.

***Isopterygium minutirameum* (C. Müller) Jaeger variety *brevifolia* Fleischer.**

Nukuhiva, 1922?, E. H. Quayle no. 1317; Nukuhiva, cool, shaded, moist conditions in cloud zone, on *Hibiscus tiliaceus*, July 20, 1921, F. B. H. and E. D. W. Brown no. 537.

These collections seem to be identical in every essential particular with Fleischer's no. 449 Musc. Arch. Ind. et Polynes. It is an interesting range extension of a species recently reported from Fiji by Mr. H. N. Dixon and may therefore be expected from some of the intervening parts of Polynesia.

SOCIETY ISLANDS

***Fissidens Nadeaudii* Bescherelle.**

Tahiti, 1922?, E. H. Quayle nos. 213a, 212a.

***Campylopus sulphureus* Bescherelle.**

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697; Tahiti, 1922?, Whitney Expedition no. 702.

Both collections are richly fruited and only 2-3 cm. high, much shorter than specimens collected by Tamarii and determined by Bescherelle which are in my herbarium. The leaf structure is so nearly identical, however, that I have but little doubt that they are referable to this species. The leaves are not at all auriculate and the cells at the basal angles are scarcely differentiated from those of the leaf base.

***Campylopus nudicaulis* Bescherelle.**

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697a.

These plants agree fairly well with the description of *C. nudicaulis* but in the absence of any authentic specimens for comparison the determination is not sure.

The auriculate leaves, the clearly differentiated alar cells extending to the costa, and the very different basal areolation clearly separate the plant from *C. sulphureus*.

Many of the plants have apical clusters of minute-leaved flagellate branches similar to those produced by other plants of various allied dicranaceous genera. These, no doubt, serve the purpose of asexual reproduction.

Campylopus umbellatus (Walker-Arnett) Bartram.

Tahiti, 1922?, E. H. Quayle nos. 208, 212c.

Holomitrium vaginatum (Hooker) Bridel.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697k.

Dicranoloma Braunii (C. Müller) Paris.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle nos. 154b, 156c.

This is a noteworthy extension in the range of the species. It has recently been found in Fiji so that the distribution of the species is now fairly continuous from Sumatra to Tahiti. *D. Graffeanum* (C. Müller), of Samoa, is, as Mr. Dixon has remarked, probably the same thing and should be reduced to synonymy.

Dicnemon rugosum (Hooker) Schwaegrichen.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle no. 155c; Tahiti, Pirae-Moua trail, August 1-3, 1922, E. H. Quayle no. 699b; Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697a; Tahiti, Whitney Expedition, 1922?, nos. 704, 705.

Leucobryum scalare C. Müller, variety **tjibodense** Fleischer.

Tahiti, Fautaua, July 28, 1922, Whitney Expedition; Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle nos. 162, 165, 166.

So far as I know the nearest recorded station for this species is in the Philippines so that its occurrence in Tahiti is noteworthy.

The leaves of the Tahitian plants are erect and appressed with scarcely any evident falcate tendency, thus approaching Fleischer's variety more nearly than it does the typical form of the species.

Exodictyon Nadeaudii (Bescherelle) Cardot.

Tahiti, upper Papenoo Valley, on tree trunk with ferns, elevation 800 m., May 18, 1927, L. H. MacDaniels no. 1540a.

Thyridium obtusifolium (Lindberg) Fleischer.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle no. 663a.

Calymperes tahitense (Sullivant) Mitten.

Tahiti, Pueu, on rocks with ferns, elevation 250 m., May 26, 1927, L. H. MacDaniels no. 1577.

***Calymperes Quaylei* new species (fig. 8).**

C. Motleyi Mitten affine. Differt cellulis majoribus, papillatis, 10-15 μ , costa parum latioribus.

Plants densely tufted, yellowish green above, brown below. Stems simple, up to 1.5 cm. high. Normal leaves erect with incurved points when dry, erect-spreading when moist, about 1.25 mm. long, oblong-ovate, obtuse; margins erect, minutely crenulate with papillae; costa strong, ending just below the apex, scabrous on the back, about 60 μ wide toward the base; upper leaf cells rounded-hexagonal, 10-15 μ in diameter, papillose on both sides, teniolae none, cancellinae shorter than the leaf base, broadly rounded above, in about 5 rows, bordered on the margins with 4-5 rows of short rectangular to quadrate cells similar to those of the lamina, but nearly smooth. Abnormal leaves abruptly contracted to a wide point, broadly rounded and toothed at the apex; costa stronger than in the normal leaves, scabrous on the back to the top of the cancellinae, ending in or below the apex.

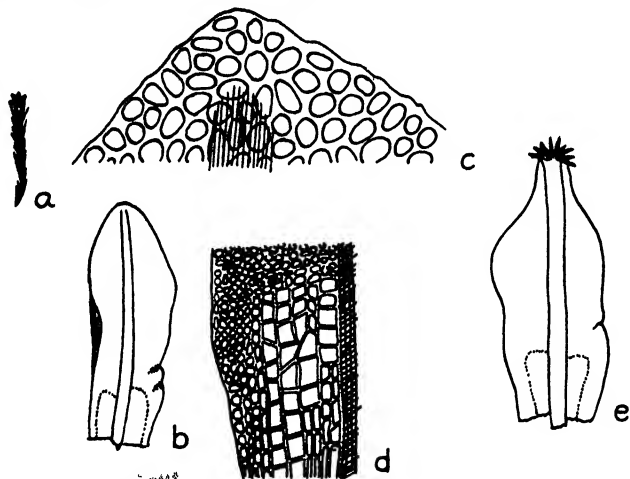


FIGURE 8.—*Calymperes Quaylei* Bartram: a, plant, $\times .9$; b, normal leaf, $\times 25.5$; c, apex of normal leaf, $\times 377.5$; d, one side of leaf base, $\times 120$; e, abnormal leaf, $\times 25.5$.

Type: Scilly, January 1, 1922, E. H. Quayle no. 227.

The much larger leaf cells and the costa ending below the apex separate this species from *C. tenerum*. It is apparently closer to *C. Motleyi* Mitten, but the relatively broader and shorter leaves and especially the larger, papillose leaf cells will distinguish it at once from this species.

***Bryum leptothecium* Taylor.**

Tahiti, 1922?, E. H. Quayle no. 212b.

Breutelia Eugeniae Aongstrom.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle nos. 697e, 698a.

Hypnodendron Vescoanum Bescherelelle.

Tahiti, 1922?, E. H. Quayle nos. 96, 212.

Mniodendron tahiticum Bescherelelle.

Tahiti, Whitney Expedition 1922, no. 703d; Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 6971.

Spiridens Balfourianus Greville.

Tahiti, 1922?, E. H. Quayle nos. 62, 197, 201.

Zygodon Reinwardtii (Hornschuch) Al. Braun, variety **subintegrifolius** Malta.

Tahiti, Pirae-Moua Aorai trail, August 1-3, 1922, E. H. Quayle nos. 697, 699.

Dr. Malta has very kindly confirmed my determination of this well-marked variety with the comment that, although it could only be indicated from South America when his monograph of the genus *Zygodon* was published, he did not consider it as a form peculiar to that region but rather supposed it to be distributed throughout the range of this polymorphous species.

Macromitrium eurymitrium Bescherelelle.

Tahiti, Fautaua, July 28, 1922, Whitney Expedition.

Macromitrium ruginosum Bescherelelle.

Tahiti, Pirae-Moua trail, August 1-3, 1922, E. H. Quayle; Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle no. 148d.

Macromitrium subtile Schwaegrichen.

Tahiti, Pirae-Moua Aorai trail, August 1-3, 1922, E. H. Quayle.

Macromitrium owahiense C. Müller.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle nos. 697c, 699; Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle nos. 152a, 153b, 154, 165; Tahiti, Whitney Expedition, 1922?, nos. 698, 699c, 704b.

Ptychomitrium aciculare (Bridel) Mitten.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation,

September 22-24, 1921, E. H. Quayle nos. 150, 151, 152, 160; Tahiti, 1922?, E. H. Quayle no. 77; Tahiti, Pirae-Moua trail, August 1-3, 1922, E. H. Quayle; Tahiti, south of Orohena, on trees with ferns, elevation 1500 m., L. H. MacDaniels no. 1454.

Rhacopilum cuspidigerum (Schwaegrichen) Mitten.

Tahiti, 1922?, E. H. Quayle no. 211.

Trachyloma tahitense Bescherelle.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle no. 147a; Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697j; Tahiti, Whitney Expedition 1922?, no. 701.

Garovaglia tahitense Bescherelle.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697n.

Symphysodontella cylindracea (Montagne) Fleischer.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle no. 156b.

Papillaria helictophylla (Montagne) Brotherus.

Tahiti, 1922?, E. H. Quayle no. 76.

Papillaria Aongstroemiana C. Müller.

Tahiti, Maire Valley, Teahupa, on tree trunks with fern, elevation 200 m., June 7, 1927, L. H. MacDaniels no. 1638; Tahiti, on rocks, 1921-22, F. B. H. and E. D. W. Brown; Tahiti, Whitney Expedition 1922?, 698b, 700; Tahiti, Fautaua Canyon, July 28, 1922, E. H. Quayle no. 661a; Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle nos. 153a, 155, 157a, 161, 159; Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle, nos. 697b, 697l.

Aerobryopsis vitiana (Sullivant) Fleischer.

Tahiti, south of Orohena, on trees with *Lycopodium*, elevation 1400 m., May 17, 1927, L. H. MacDaniels no. 1472.

Floribundaria aeruginosa (Mitten) Fleischer.

Tahiti, 1922?, E. H. Quayle no. 213.

Calyptothecium Urvilleanum (C. Müller) Brotherus.

Tahiti, 1922?, E. H. Quayle no. 98a.

Neckeropsis Lepineana (Montagne) Fleischer.

Tahiti, 1922?, E. H. Quayle no. 98; Tahiti, on rocks, 1921-22, F. B. H. and E. D. W. Brown.

Distichophyllum tahitense Bescherele.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle no. 697-0; Tahiti, Whitney Expedition 1922?, nos. 704c, 706a.

Callicostella vesiculata C. Müller.

Tahiti, Fautaua Canyon, elevation 400-500 m., July 28, 1922, E. H. Quayle no. 663a.

Callicostella papillata (Montagne) Jaeger.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle no. 661.

Hypopterygium tahitense Aongstrom.

Tahiti, Pirae-Moua Aorai Trail, August 1-3, 1922, E. H. Quayle.

Thuidium furfurosum (Hooker f. and Wilson) Jaeger.

Tahiti, 1922?, E. H. Quayle no. 77.

New to Tahiti and an interesting range extension of this very plastic species.

In addition to the clearly catenulate branch leaves, the stem leaves are very broadly cordate, often twice as broad as long, and abruptly contracted to a curved subula formed by the excurrent costa. I believed them to represent a new species until Mr. Dixon sent me specimens of *T. furfurosum* from New Zealand showing stem leaves so nearly similar that it seems unwise to separate the collection from Tahiti in the absence of any distinguishing characters.

Thuidium ramosissimum Dixon and Bartram, new species (fig. 9).

Dioicum. Caulis gracilis, 3-4 cm. longis, bi-tripinnatis. Folia caulina triangulari-ovata, marginibus planis, costa ante apicem evanida; cellulis inferioribus papillois, superioribus laevis, folia ramulina multo minora.

Dioicous. Slender plants growing in extensive mats, yellowish green above, brown below. Stems 4-5 cm. long, bipinnately to tripinnately branched, the ultimate branches filiform and minute leaved, paraphyllia scanty, usually of one row of cells, simple or branched. Stem leaves erect-spreading, about 0.5 mm. long, triangular-ovate from a subcordate base, rather abruptly short acuminate, concave, faintly plicate below; costa thin and faint, ending near the base of the acumen; margins plane, minutely crenulate with papillae; leaf cells irregularly oval-rhomboidal with firm, pellucid walls, nearly or quite smooth above, papillose toward the base, branch leaves smaller, ovate, those of the ultimate

branches about 0.12 mm. long, bluntly pointed, the cells with 2 or 3 short, but very evident papillae.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle nos. 663a (type), 663, 662b.

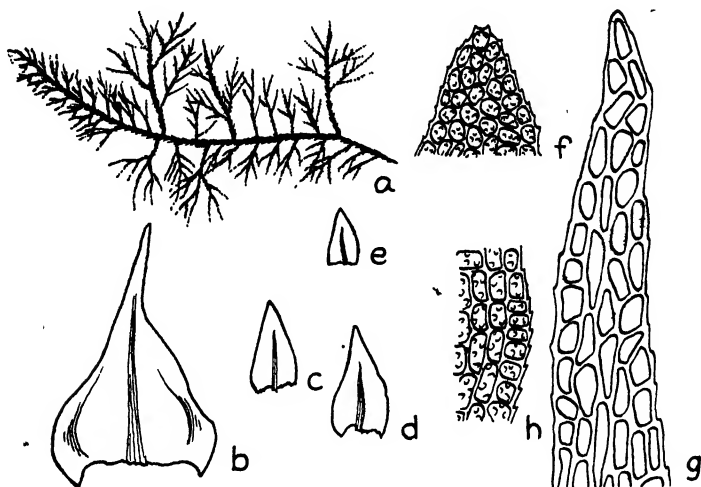


FIGURE 9.—*Thuidium ramosissimum* Dixon and Bartram: a, plant, $\times .9$; b, stem leaf, $\times 60$; c-e, branch leaves, $\times 60$; f, apex of branch leaf, $\times 377.5$; g, apex of stem leaf, $\times 377.5$; h, basal cells and margin of stem leaf, $\times 377.5$.

These plants, though very slender in the ultimate branching, are decidedly more robust than *T. tahitense* Brotherus. I was at first inclined to think they belonged in the section *Thuidiopsis*, but after examining a part of the collection Mr. Dixon is of the opinion that they are better placed in the section *Euthuidium*. Their relationship to the other species is an open question, but it is certain that the plants represent a type previously unknown from Tahiti and obviously distinct from *T. furfurosum*.

Brachythecium longipes Brotherus.

Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle nos. 697d, 697h; Tahiti, Whitney Expedition 1922, nos. 701a, 702b, 703, 704d, 705a, 706d.

This species was noted by Brotherus (Nat. Pflanzenf., ed. 2, vol. 11, p. 366, 1925) in a collection by Nadeaud no. 365, distributed by Bescherelle as *B. tearapense* Bescherelle. My specimen of Nadeaud's

no. 365, determined by Bescherelle, consists of two tufts, one of which has scabrous setae and clearly represents *B. tearapense*, the other of which has long, smooth setae evidently referable to *B. longipes* Brotherus.

As no description of *B. longipes* has been published, so far as I am aware, a brief summary of the characters may be useful. It is apparently an abundant moss along the Pirae-Moua Aorai trail, where numerous and abundant collections in fine fruit were obtained by the Whitney Expedition.

Autoicous. Pale green, glossy. Stems up to 4-5 cm. long, irregularly branched, flattened, about 4 mm. wide with leaves. Leaves ovate-lanceolate, long acuminate, plicate, up to 2.5 mm. long by 1 mm. wide; costa very thin and faint, rarely extending halfway up and often almost entirely lacking; margins plane, denticulate all around; cells very long and narrow, decidedly more lax in a few rows across the extreme base. Seta 2.5-4 cm. long, reddish brown to almost black, smooth; capsule short oblong, brown or blackish, arcuate and horizontal; opercum conic.

The plants resemble *B. lamprocarpum* (C. Müller) Jaeger to some extent but appear to be quite distinct in the consistently longer setae and the larger leaves with an unusually indistinct costa.

Brachythecium tearapense Bescherelle.

Tahiti, 1922?, E. H. Quayle no. 211a.

Entodon Solanderi (Aongstrom) Jaeger.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle nos. 660, 662, 662a; Tahiti, Whitney Expedition 1922?, no. 604; Tahiti, on rocks, F. B. H. and E. D. W. Brown.

Meiothecium Rechargingeri Brotherus.

Tahiti, Pirae-Moua Aorai trail, August 1-3, 1922, E. H. Quayle.

Although most of the leaves on these plants are definitely obtuse or rounded at the point, a few from every stem examined show a close approach to *M. hamatum* (C.M.) (tab. 219, Bryol. Javanica). The average, however, is constantly shorter and more rounded, so I have tentatively referred these plants to *M. Rechargingeri* Brotherus, of Samoa, although the color is a golden brown rather than green. At any rate it is a fine addition to the local flora and new to Tahiti.

Rhaphidorrhynchium Quaylei new species (fig. 10).

Autoicum. Caulis gracilis, irregulariter pinnatis, ramis brevibus, prostratus. Folia ovato-lanceolata, acuminata, superne minute denticulata, ecostata; cellulis

alaribus multo majoribus, oblongis, ventricosis, caeteris elongatis. Seta 4-5 mm. longa, rubra; capsula inclinata, sicca arcuata, sub ore coarctata; operculum subulatum, longirostre.

Autoicous. Slender, pale or silvery green, glossy plants growing in thin mats. Stems irregularly pinnately branched, radiculose on the under side, branches short and complanate, closely appressed to the substratum. Leaves ovate-lanceolate, gradually acuminate, 1-1.25 mm. long, concave; margin erect, minutely denticulate above, entire below; costa none; leaf cells very long and narrow, about 4μ wide by 10-14 times as long, smooth, alar cells 3-4, large, oblong, vesiculose, pale yellow, supra-alar cells few, irregularly rhomboidal. Inner perichaetial leaves abruptly contracted to a long, filiform, flexuose, denticulate point; seta very slender, bright red, smooth, 4-5 mm. long; capsule ovoid-cylindric, inclined or horizontal, contracted under the mouth when dry, urn about 0.9 mm. long; peristome teeth pale yellow, densely transversely striate, segments of inner peristome carinate, from a basal membrane about half the height of the teeth, cilia one, slightly shorter than the segments; operculum subulate-rostrate, nearly as long as the urn; calyptra cucullate, extending about halfway down the urn; spores pale, smooth, $10-12\mu$ in diameter.

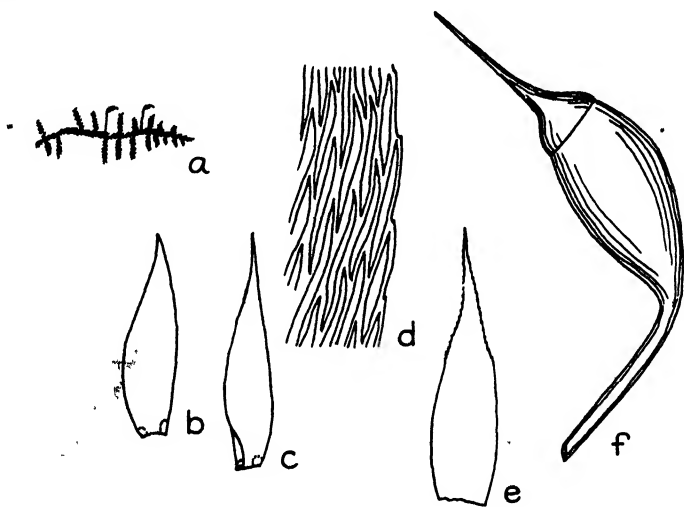


FIGURE 10.—*Rhabdorrhynchium Quaylei* Bartram: a, plant, $\times .9$; b-c, leaves, $\times 25.5$; d, upper leaf cells and margin, $\times 377.5$; e, perichaetial leaf, $\times 25.5$; f, capsule and lid, $\times 25.5$.

Type: Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle no. 663.

As far as I know no species of the section *Microcalpe* has been recorded before from Polynesia or in fact from any of the Pacific islands. These plants suggest *R. rufulum* Bescherelle, of Guadeloupe,

but are apparently quite distinct in the pale color, broader leaves, and different perichaetial leaves. My specimen of *R. rufulum* (Duss no. 1266), named by Bescherelle, deviates from the original description in having the setae up to 1 cm. long and the leaf margins sharply denticulate above.

Acroporium Lepinei (Bescherelle) Fleischer.

Tahiti, trail to summit of Moua Aorai, above 1386 m. elevation, September 22-24, 1921, E. H. Quayle nos. 147, 149, 155b, 157, 158, 163; Tahiti, Whitney Expedition 1922?, nos. 702, 705c; Tahiti, Pirae-Aorai trail, August 1-3, 1922, E. H. Quayle, no. 697; Tahiti, south side of Orohena, on tree trunk, May 16, 1927, L. H. MacDaniels no. 1553.

Trichosteleum hamatum (Dozy and Molkenboer) Jaeger.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle nos. 661, 666.

These collections, and particularly no. 666, represent a variant with asymmetrical, broadly ovate-lanceolate, deeply concave leaves often conspicuously contracted just above the insertion; the upper cells are short oval with 2-3 large papillae over the lumens. I believe this is only one of the forms of this very variable and widely distributed species.

Taxithelium Vernieri (Duby) Bescherelle.

Tahiti, Fautaua Canyon, shady, damp, elevation 400-550 m., E. H. Quayle no. 669a.

Fleischer reduces this species to a synonym of *T. Lindbergii* (van den Bosch et Lacoste) Renauld and Cardot (Laubm. v. Java, vol. 4, p. 1347), but I feel more inclined to follow Brotherus, (Engler and Prantl, Pflanzenf., ed. 2, vol. 11, p. 443), in keeping them separate.

In *T. Vernieri* the branch leaves are well spaced, distinctly complanate and minutely crenulate to nearly entire on the apical margins. In *T. Lindbergii* the branch leaves are crowded, falcate-secund, and sharply toothed on the apical margins. These distinctions seem to be constant and are well marked in a comparison of Duby's illustration (tab. 271, Bryol. Javanica).

Glossadelphus tahitensis, new species (fig. 11).

Autoicus. Caulis ad 3 cm. longus, irregulariter ramosus. Folia ovata, concava, obtusa, toto ambitu denticulata; costis binis; cellulis linearibus, pluri-

papillosis. Seta ad 2.5 cm. longa, laevis, rubra; capsula oblonga, gibbosa; operculum conicum, apiculatum.

Autoicous; male buds minute, numerous, about 0.25 mm. long, antheridia 6-8 with a few short paraphyses, enclosed in about 6 broadly ovate, obtuse perigonal leaves with lax, smooth cells. Densely tufted plants, yellow above, pale brown below, not glossy. Stems up to 3 cm. long, compactly and irregularly branched, branches flexuose, ascending, blunt at the tips. Leaves ovate, concave, obtuse or broadly rounded at the apex, rarely truncate, 1 mm. long by 0.5 mm. wide; margin erect, denticulate all around and papillose-crenulate; costa double, variable in length, but often extending halfway up the leaf; leaf cells linear, 5μ wide by 8-12 times as long, with numerous (10-16) minute but distinct papillae over the lumens, the marginal row near the apex shorter and rhomboidal, shorter and more lax in several rows at the extreme base, without any differentiated alar cells. Inner perichaetial leaves ovate-lanceolate, acuminate, 1.5 mm. long, ecostate, lower cells lax and smooth, upper cells papillose; seta red, smooth, flexuose, up to 2.5 cm. long; capsule asymmetrical, short oblong, horizontal, urn about 1 mm. long, arcuate and constricted under the mouth when dry and empty, exothecal cells hexagonal, not collenchymatous; peristome normal; lid conic, apiculate, 0.6 mm. long; spores smooth, 15μ in diameter.

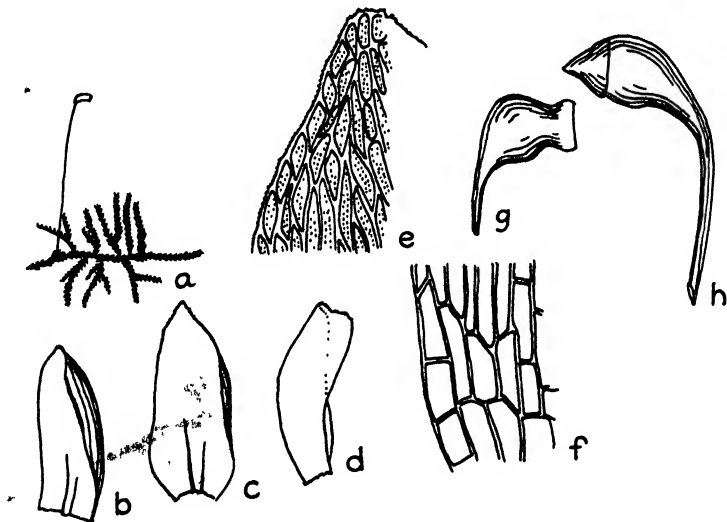


FIGURE 11.—*Glossadelphus tahitensis* Bartram: a, plant, $\times .9$; b-d, leaves, $\times 25.5$; e, apex of leaf, $\times 377.5$; f, basal angle of leaf, $\times 377.5$; g, dry capsule, $\times 10.5$; h, moist capsule, $\times 10.5$.

Type: Tahiti, Pirae-Aorai trail, August 1-3, 1922, Whitney Expedition no. 697.

This is an interesting plant combining the papillose leaf cells of *Taxithelium* with the characteristic blunt, costate leaves of *Glossadel-*

phus. It will be distinguished at once from *G. torrentium* (Besch-erelle) Fleischer by the papillose leaf cells.

Ectropothecium sodale (Sullivant) Mitten.

Tahiti, Fautaua Canyon, elevation 400-550 m., July 28, 1922, E. H. Quayle nos. 662c, 666a, 669b, Lake Vaihria, elevation 650 m., in moist soil at base of a *Polypodium*, June 3, 1927, L. H. MacDaniels no. 1598.

Vesicularia inflectens (Bridel) C. Müller.

Tahiti, Fautaua Canyon, shady, damp, elevation 400-550 m., E. H. Quayle no. 669; Tahiti, Maire Valley, Teahupo, moist, shady, elevation 10 m., June 7, 1927, L. H. MacDaniels no. 1652.

Ctenidium stellulatum Mitten.

Tahiti, trail to summit of Moua Aorai, above 1386 m., September 22-24, 1921, E. H. Quayle no. 147.

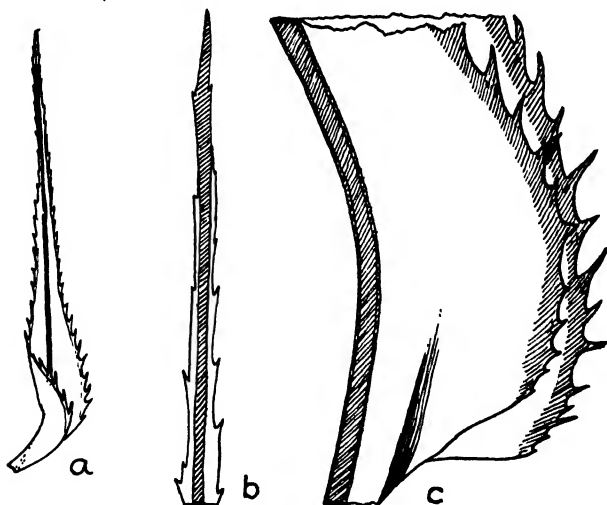


FIGURE 12.—*Spiridens armatus* Bartram: *a*, leaf, $\times 10.5$; *b*, apex of leaf, $\times 60$; *c*, base of leaf, $\times 60$.

COOK ISLANDS

Syrhophodon Banksii C. Müller.

Rarotonga, May-July, 1929, H. E. and S. T. Parks no. M.10.

Spiridens armatus, new species (fig. 12).

S. Balfouriano affine. Caulis ad 16 cm. altus, parce ramosus; costa in cuspidem brevem excurrent; foliorum margines arcte ciliato-dentati.

The long, curved, cillialike teeth extending down the margins to the top of the short, clasping leaf base seem to clearly separate this species from either *S. Balfourianus* or *S. Reinwardtii*.

Macromitrium Nadeaudii Beschereille.

Rarotonga, May-July, 1929, H. E. and S. T. Parks no. M.5.

Symphysodon vitianus (Sullivant) Brotherus.

Rarotonga, May-July, 1929, H. E. and S. T. Parks no. 22142.

Eurhynchium vagans (Harvey) Bartram.

Rarotonga, May-July, 1929, H. E. and S. T. Parks no. M.6.

Taxithelium tenuisetum (Sullivant) Mitten.

Rarotonga, May-July, 1929, H. E. and S. T. Parks no. M.8.

TONGA ISLANDS

Brachymenium melanothecium (C. Müller) Jaeger.

- Tongatabu, June-August, 1926, W. A. Setchell and H. E. Parks no. M.2.

Macromitrium tongense Sullivant.

Tongatabu, W. A. Setchell and H. E. Parks, June-August, 1926, no. M.1.

Ectropothecium tutuilum (Sullivant) Mitten.

Eua Island, June-July, 1926, H. E. Parks no. M.9.

LAND SHELLS OF MAKATEA

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C. MONTAGUE COOKE, JR.

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LAND SHELLS OF MAKATEA

By C. MONTAGUE COOKE, JR.

The island of Makatea (Aurora, Metia, Matea) has probably not been visited by malacologists since the time of the United States Exploring Expedition (1839). The only references to the land shells of this island which I find in the available literature are those given by Gould or on specimens that probably came from him. Garrett, who lived for many years in the Society Islands and visited many other Polynesian islands, evidently did not visit Makatea. In his papers I find no allusion to Gould's species and in his collection no shells from this island.

Bernice P. Bishop Museum has been fortunate in receiving two large representative collections from the little-known island of Makatea. The first was a package of about a peck of soil, moss, and fragments of rotten wood from under a rotten log. This material was collected on "the northwest rim of the plateau, under heavy forest at about 300 feet elevation" by Mr. K. P. Emory in March 1930. After drying and sifting this material nearly 600 shells were picked out, and 16 species belonging to 10 genera were identified. This was more than three times the number of species recorded by Gould. All the shells were dead.

In October 1932, Mrs. G. P. Wilder, who accompanied her husband to Makatea on a botanical expedition, collected 8 packages of "sweepings" from under dead logs and stones, 7 packages of moss and lichens from stones and dead logs, and 5 vials of shells preserved in alcohol from the backs of the leaves of ti (*Taetsia fruticosa*) and fronds of the birdsnest fern (*Asplenium nidus*). These lots were collected from near sea level to 300 feet elevation.

Slightly more than 80 percent of the 2100 shells collected by Mrs. Wilder were found in sweepings from one locality at an elevation of 250 feet "gathered around coconut trees in pockets of coral rocks." All the shells were dead when collected. From this lot 15 species belonging to 11 genera were identified. Altogether 19 species belonging to 15 genera were identified from Mrs. Wilder's material, which contains all but 3 of the species now known to inhabit Makatea.

Besides the shells collected by Mrs. Wilder and by Mr. Emory, a

single specimen of *Nesopupa pleurophora* was found on a lichen in the Museum herbarium. This was collected by W. B. Jones in 1922.

All but 4 of the 22 species now known to inhabit Makatea have been reported from other Polynesian islands. One of these, *Cyclomorpha obligata*, has been identified with *Cyclomorpha flava* Broderip from the island of Anaa about 170 miles southeast of Makatea. Typical examples of both species are easily separated and, in the absence of any intergrading specimens, I have considered the two as distinct species. The only other species which might be considered endemic are *Microcystis pertenuis* (Gould), *Thaumatodon daedalea* (Gould), and *Aphanoconia trochlea* (Gould). None of these have been reported from any other island. The remaining 18 species belong to widely dispersed species most of which are common on several, if not most, of the Polynesian islands.

A few of the widely distributed Polynesian species of land shells are not found in the Makatean fauna in the material which I have examined. These are frequently found associated with the more common Makatean species. They are *Liardetia samoensis* (Mousson), *Trochonanina calculosa* (Gould), *Tornatellides simplex* (Pease), and *Assiminea nitida* (Pease).

From existing knowledge of the distribution of the species of land shells enumerated below, it is evident that the island of Makatea has a very low percentage of endemism. I have little hesitation in predicting that the four species now known only from this island may be found in the Society Islands or the neighboring islands of the Tuamotu Archipelago. It is probable that the remaining 18 species were accidentally introduced by man with the introduction of plants. Most of these were probably carried by Polynesians, but about six (*Gastropoda lyonsiana*, *Pupisoma orcula*, *Subulina octona*, *Prosopoeas javanicum*, *Opeas gracile*, and *Opeas clavulinum*) have arrived since the advent of the white race into the Pacific.

Microcystis pertenuis (Gould).

Helix pertenuis Gould: Boston, Soc. Nat. Hist. Proc., vol. 2, p. 172, 1846; U. S. Expl. Exped., Mollusca, p. 45, pl. 5, figs. 60, a-c, 1852.

No shells belonging to this species were found by Mr. Emory or Mrs. Wilder. The depressed spire and the absence of the perforation

prevent this species from being confused with *M. discordia* Garrett, which was found by both Mr. Emory and Mrs. Wilder.

Microcystis discordia Garrett.

Microcystis discordia Garret: Acad. Nat. Sci., Phila. Jour., vol. 8, p. 383, 1881; vol. 9, p. 20, pl. 2, figs. 35, *a-b*, 1884.

This small zonitoid was abundant in the material collected by Mr. Emory, but only six were taken by Mrs. Wilder, from three localities. Two were alive. These were at first identified as *Microcystis pertenuis* (Gould), but on closer examination they proved to be *Microcystis discordia* Garrett. Although the periphery is obtusely angular, the spire is proportionately higher than the figure given by Gould, and all the specimens in Bernice P. Bishop Museum are perforate.

Most of the Makatean specimens are dead and somewhat smaller than those collected by Garrett in the Society Islands and have nearly one-half whorl less. One of them measures: diameter, 3.4 mm.; altitude, 2.3 mm.

Thaumatodon dædalea (Gould).

Helix dædalea Gould: Boston, Soc. Nat. Hist., Proc., vol. 2, p. 173, 1846; U. S. Expl. Exped., Mollusca, p. 54, pl. 4, figs. 51, *a-d*, 1852.

Although Gould gives Tahiti as one of the habitats of this species, it is not mentioned by Garrett in his "Terrestrial Mollusca of the Society Islands." Gould reports this species as abundant under stones. It was not found by Mr. Emory. Mrs. Wilder took a fine series of dead shells at an elevation of 250 feet in soil in pockets of coral rocks and a few at 300 feet under a dead coconut log. Two other small lots were taken at elevations of 250 and 300 feet in moss growing on coral rocks.

This species cannot be referred to any species from the Society Islands in the Garrett collection.

Libera species ?

A single dead and partly broken shell of this genus was taken in moss growing on coral stones by Mrs. Wilder at an elevation of 250 feet. It does not belong to any of the species from the Society Islands as represented in the Garrett collection. The periphery is extremely sharp, more so than in that of any other species, and the sutures are not impressed as in species from the Society Islands. The periphery

of each of the three median whorls extends over the whorl below as a slightly sharp, raised ridge. From these characters it is clearly more closely related to *Libera fratercula* from Cook Islands than to any species from the Society Islands. The surface texture, though badly worn, is finer than that of *L. fratercula*. The basal portion of the aperture is broken, so the complete armature of the aperture is lacking. Because the shell is incomplete, I hesitate to describe it as a new species.

***Subulina octona* (Brugière).**

(For synonymy and distribution see Pilsbry, Man. Conch., vol. 18, pp. 73, 223, 1906.)

This widespread tropical species was taken by Mr. Emory and also by Mrs. Wilder, who found it at eight localities at elevations of 100 to 300 feet. As this species is present in Hawaii and other islands of the Pacific, I would assume that it will be found in all parts of Makatea from a few feet above high-water mark.

***Prosopeas javanicum* (Reeve).**

Achatina javanicum Reeve, Conch. Icon., vol. 5, pl. 17, fig. 79. 1849. (For synonymy and distribution see Pilsbry, Man. Conch., vol. 18, p. 138, 1906.)

Many shells of this species were taken by Mrs. Wilder at 250 feet. It is probably abundant all over Makatea associated with *Subulina octona* and *Opeas oparanum*.

***Opeas oparanum* (Pfeiffer).**

Bulimus oparanum Pfeiffer: Zool. Soc. London, Proc., p. 34, 1846.

(For synonymy and distribution see Pilsbry, Man. Conch., vol. 18, p. 183, 1906.)

This species was collected by Mr. Emory and also by Mrs. Wilder, who found it at seven localities. The Makatean shells agree closely with those of this species collected by Mrs. J. F. G. Stokes on the island of Rapa in 1921.

***Opeas gracile* (Hutton).**

Bulimus gracile Hutton: Asiatic Soc., Bengal, Jour., vol. 3, p. 84, 1834. (For synonymy and distribution see Pilsbry, Man. Conch., vol. 18, p. 125, 1906.)

I have referred to this species specimens collected by both Mr. Emory and Mrs. Wilder. These shells are more slender, with less

convex whorls, and smaller embryonic whorls than those referred to *O. oparanum*. Many of these shells have whorls nearly as flat as specimens identified as *O. goodalli* from Oahu by Pilsbry, but they probably do not belong to this species, as the adult shells are somewhat larger than any from Oahu in the Bishop Museum collections. Those collected by Mrs. Wilder came from near or under logs, altitude 250 to 300 feet.

Opeas clavulinum (P. and M.).

Bulinus clavulinus Poties and Michaud: Gal. Moll. Mus. Donai, vol. 1, p. 136, pl. 14, figs. 9-10, 1838.

Opeas clavulinum Pilsbry: Man. Conch., vol. 18, p. 135, pl. 23, figs. 17, 21, 22, 1906.

Shells collected on Makatea are nearer to this species than to any other reported from the Pacific region. The outlines of the upper whorls are closer to Pilsbry's figure of *O. clavulinum* (pl. 23, fig. 21) than to *O. mauritianum* Pfeiffer or *O. opella* Pilsbry and Vanatta identified by Pilsbry in the Bishop Museum collection from Hawaii.

Mrs. Wilder's material consists of five lots from under or near dead logs and in pockets in stones, altitudes 250 to 300 feet.

Gastrocopta pediculus (Shuttleworth).

Pupa pediculus Shuttleworth: Naturf. Gesells. Bern, Mittheil., p. 296, 1852.

Gastrocopta pediculus Pilsbry: Man. Conch., vol. 24, p. 145, 1917.

Typical shells of this widespread Polynesian species were taken by Mr. Emory and by Mrs. Wilder. All were dead. Mrs. Wilder's material came from five localities under dead coconut logs, in soil from rock pockets, and from moss growing on coral rocks, altitudes 250 to 300 feet.

Gastrocopta lyonsiana (Ancey).

Pupa lyonsiana Ancey: Soc. Zool. France, Mem., vol. 5, p. 713, 1892.

Gastrocopta lyonsiana Pilsbry: Man. Conch., vol. 24, p. 141, 1917.

Shells agreeing with Ancey's type in Bernice P. Bishop Museum were found by both Mr. Emory and Mrs. Wilder but are much rarer than *G. pediculus*. Mrs. Wilder's material consists of only two specimens taken at altitude 250 feet, one in earth in rock pockets and one in moss growing on coral rocks.

Nesopupa pleurophora (Shuttleworth).

Pupa pleurophora Shuttleworth: Naturf. Gesells. Bern, Mittheil., p. 296, 1852.

Nesopupa pleurophora Pilsbry: Man. Conch., vol. 25, p. 326, 1920.

A fine series of this species was taken by Mr. Emory. Mrs. Wilder found a few in rock pockets, under rotten logs, and in moss, altitude 250 and 300 feet. Mr. W. B. Jones also collected one under lichens growing on a dead *Pandanus* log, altitude 300 feet.

At first I was inclined to place some of these specimens under *N. tantilla* (Gould). The more numerous teeth (8-9) of nearly all the shells would place them nearer to *N. pleurophora* than to *N. tantilla*.

Nesopupa armata (Pease).

Vertigo armata Pease: Zool. Soc. London, Proc., p. 461, 1871.

Nesopupa armata Pilsbry: Man. Conch., vol. 25, p. 327, 1920.

A few typical shells were taken by Mr. Emory. They are easily separated from those of *N. pleurophora* by being slightly longer and by the strong oblique upper palatal fold.

Pupisoma orcula (Benson).

Helix orcula Benson: Ann. Mag. Nat. Hist., vol. 6, p. 251, 1850.

Pupisoma orcula Pilsbry: Man. Conch., vol. 26, p. 31, pl. 2, figs. 1-5, 1920; vol. 27, p. 228, 1926 (Hawaiian reference).

Eight shells of what is probably this species were found in the Emory material. Mrs. Wilder collected a single live specimen on a ti leaf. They are much closer to shells figured by Pilsbry (especially his figure 2) than to Hawaiian shells identified by Pilsbry under this name. Compared to those from Hawaii, the Makatean shells are narrower, with a proportionately higher spire. The spiral lines on the base are easily made out with a high-powered lens.

Elasmias ovatum apertum (Pease).

Tornatellina aperta Pease: Zool. Soc. London, Proc., p. 673, 1864.

Elasmias ovatum apertum Pilsbry and Cooke, Man. Conch., vol. 23, p. 120, 1915.

Three typical examples of this subspecies were taken by Mrs. Wilder on leaves of shrubs, altitude 175 feet.

Lamellidea pusilla (Gould)

Partula pusilla Gould: Boston Soc., Proc., vol. 2, p. 197, 1847;

U. S. Expl. Exped., Mollusca, p. 83, pl. 7, figs. 90, 90a, 1852.

Tornatellina (Tornatellinops) pusilla Pilsbry and Cooke: Man. Conch., vol. 23, p. 176, 1915.

In the fine series of this species taken by Mr. Emory all stages of growth are represented. It was also taken by Mrs. Wilder from five localities, altitude 150 to 300 feet. All of these were dead when taken except one shell found by Mrs. Wilder on a ti leaf. Additional material was taken by Mrs. Wilder under dead coconut logs and in pockets in coral rocks.

An examination of Pease's type lots of *L. nitida* and *L. serrata* in the British Museum proves that the types of *L. serrata* represent paraneanic or metaneanic stages of *L. nitida*, which should be considered as a pure synonym of *L. pusilla*. *L. oblonga* (Pease) and *L. pusilla* (Gould) are two of the most widespread species of the genus. Their habit of living commonly on the ground on dead leaves and stones makes them easy subjects for transportation. Up to the present only *L. oblonga* has been found in Hawaii. Both species are found associated together in nearly all the groups of islands of the central Pacific.

Lamellidea oblonga (Pease).

Tornatellina oblonga Pease, Zool. Soc., Proc., p. 673, 1864.

Tornatellina (Lamellina) oblonga Pilsbry and Cooke, Man. Conch., vol. 23, pp. 160, 162, 1915.

A fine series of this abundant and widespread species was taken by Mr. Emory. The palatal rib was present in most of the juvenile shells.

Lamellidea (Tornatellinops) variabilis Odhner.

Pacificella variabilis Odhner, Nat. Hist. Juan Fernandez and Easter Island, vol. 3, pt. 2, p. 249, pl. 8, figs. 15-17, 1922.

Lamellidea variabilis Pilsbry and Cooke, The Nautilus, vol. 47, p. 60, 1933.

This widespread form of Odhner's species was taken by Mrs. Wilder in six localities. Dead shells were taken under dead coconut logs, altitude 250 and 300 feet, live ones on the leaves of ti at 150 feet and on the backs of birdsnest fern at 10 feet. A single live specimen was taken in moss, altitude 250 feet. All these are typical when compared with material from Palmyra Island. A series of the same or a closely related species was found in the material collected by Mr. Emory.

***Truncatella (Taheitia) scalariformis* Reeve.**

Truncatella scalariformis Reeve, Zool. Soc. London, Proc., p. 197, 1842; Pfeiffer, Mon. Auric., p. 191, 1856.

I have identified Makatean specimens of this species from shells in the Garrett collection labeled "Paumotu Is.," which were collected by Garrett and probably came from the island of Anaa. They may have been part of the original stock upon which Mousson based his *T. arctecostata*. The Makatean shells differ slightly in that the sutures are not impressed and the whorls are nearly flat, the whole shell being nearly cylindrical. They have the characteristic costae of Garrett's shells. Makatean shells are about 6.5 mm. long, with from 29 to 38 costae on the last whorl. This species was collected by Mr. Emory and also by Mrs. Wilder, who found specimens at eight localities under dead logs, stones, and in moss growing on stones, altitude 100 to 300 feet.

From one locality at 250 feet, Mrs. Wilder collected a few shells which are somewhat larger than most of the others. One of them measures 7.5 by 2.7 mm. with slightly more than 4 whorls; in this there are 33 costae on the last whorl. In the juvenile shells the embryonic whorls are smooth and slightly wider than the first post-embryonic whorl. One of these with $9\frac{1}{2}$ whorls is 7 mm. long.

***Cyclomorpha obligata* (Gould).**

Cyclostoma obligatum Gould, Boston Soc. Nat. Hist., Proc., vol. 2, p. 205, 1847; U. S. Expl. Exped., Mollusca, p. 104. pl. 8, figs. 119, 119a, 1852.

A single lot of this species was taken by Mrs. Wilder, altitude 100 feet, at the top of the high bluff above the beach. These are typical specimens agreeing with Gould's description and figure. Most authors have united this species with Broderip's *C. flava* from the island of Anaa. The two forms are easily separated, *C. obligata* being consistently larger and ash-colored, the last whorl sculptured with 10 to 12 strong, sharp, widely spaced spiral ridges, which are as strong below the periphery as above. In *C. flava* the shells are smaller, yellow-orange, with about 20 low, rounded, closely spaced spiral ridges which are less conspicuous below than above the periphery. A typical specimen of *C. obligata* measures 10.7 by 9.0 mm., $5\frac{2}{3}$ whorls; and of *C. flava*, 7.8 by 6.8 mm., $5\frac{1}{2}$ whorls.

Aphanoconia trochlea (Gould).

Helicina trochlea Gould, Boston Soc. Nat. Hist., Proc., vol. 2, p. 202, 1847; U. S. Expl. Exped., Mollusca, p. 99, pl. 7, figs. 109, a-c, 1852.

This species was taken by Mr. Emory and by Mrs. Wilder from six localities, altitude 100 to 300 feet, under stones and dead logs at the roots of ferns. The shells agree well with Gould's description and figure. There is considerable individual variation in the number and degree of development of the supra-peripheral spiral ridges. Including the peripheral ridge, there may be as few as 5 in some shells; in others as many as 8 or 9. Where there are only a few ridges they are of nearly equal strength; but where many they are of unequal development. Below the periphery the base is marked with fine, almost cuticular, closely spaced spiral lines.

This interesting little species has no close relatives either from other Tuamotuan islands or from the Society Islands. It is not included in Wagner's Helicinidae.

Georissa striata (Pease).

Chondrella striata Pease, Zool. Soc. London, Proc., p. 477, 1871;

Garrett, Acad. Nat. Sci. Phila., Jour., p. 106, pl. 3, fig. 40, 1884.

Many shells of this minute species were taken by Mr. Emory and by Mrs. Wilder. Those collected by Mrs. Wilder are from six localities, altitudes 200 to 300 feet, in moss on stones and around fern roots, and also under stones and dead logs.

Two forms appear in the material from Makatea. Both agree in all characters except that in the typical form all the whorls except the embryonic are covered with close spiral striae. In the second form, which is far more abundant and sometimes occurs in pure colonies, the last whorl is nearly smooth and without spiral sculpture. The penultimate and other post-embryonic whorls are sculptured as in the typical form. The typical form was found associated with the much commoner smooth form in only three colonies.

**PANICUM, ZANTHOXYLUM, PSYCHOTRIA,
AND SICYOS**

HAWAIIAN PLANT STUDIES—2

By

HAROLD ST. JOHN

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PANICUM, ZANTHOXYLUM, PSYCHOTRIA,
AND SICYOS*

Hawaiian Plant Studies—2

By HAROLD ST. JOHN

FAMILY GRAMINEAE

Panicum pellitoides F. B. H. Brown and H. St. John, new species
(fig. 1).

Annual, 6-27 cm. tall, apparently erect, several-branched at base; culms papillose pilose, the internodes finally much exceeding the leaf sheaths; axillary branches none or frequent from the middle and upper axils; leaf sheaths 10-35 mm. long, strongly nerved, papillose pilose; ligule of hairs about 2 mm. long, scarcely separable from the general leaf pilosity; blades 6-65 mm. long, 1-4 mm. wide, flat or the margins inrolling on drying, linear and long tapering to the sharp tip, papillose pilose; panicles terminal, 13-75 mm. long, 5-50 mm. wide, at first narrow, later mostly ovoid and with divaricate branches, at first partly included in the uppermost leaf sheath, the axis and larger branches pilose, the branchlets and pedicels sparsely pilose and scabrous; spikelets 1.5-2.2 mm. long, ellipsoid; glumes pale greenish, elliptic-ovate, acute, pilosulous on the upper part, with hairs 0.5 mm. or less in length; first glume prominently 3-nerved; second glume slightly the longer, 5-nerved; sterile lemma 7-nerved, about 1/10 shorter than the second glume; fertile lemma 1 mm. long, 7-nerved, polished and shining, lead-colored; anthers cylindric, 0.5 mm. long, reddish brown; grains 1.1 mm. long, elliptic, flesh-colored.

Planta annua 6-27 cm. alta ramosa ad basim, culmis pilosis, ramis axillaribus multis vel nullis, vaginis 10-35 mm. longis valde nervosis papilloso-pilosis, laminis 6-65 mm. longis 1-4 mm. latis planis vel marginibus incurvatis linearibus acuminatis papilloso-pilosis, paniculis terminalibus 13-75 mm. longis, 5-50 mm. diametro angustis deinde ovoideis cum ramulis divaricatis, spiculis 1.5-2.2 mm. longis ellipsoideis, glumis pallidi-viridibus elliptici-ovatis acutis ad apicem pilosulis cum pilis ad 0.5 mm. longis, lemmatibus infertilibus 7-nervosis, lemmatibus 1 mm. longis 7-nervosis lucidis plumbagineis, antheris cylindraceutis 0.5 mm. longis ferrugineis, granis 1.1 mm. longis ellipticis.

Molokini: 100 feet altitude, east of center of Molokini, Aug. 13, 1925, Harold Palmer no. 16.

Island of Hawaii: erect annual, plowed field in dry pasture land, 3000 feet altitude, Puu Papapa, Waikoloa, South Kohala, April 26, 1932, G. R. Ewart 3rd no. 190; also same locality, June 16, 1932, G. R. Ewart 3rd no. 257 (type in Bishop Mus.).

* This is the second of a series of papers designed to present descriptions, revisions, and records of Hawaiian plants. The first has been published as Occ. Papers, vol. 10, no. 4, 1933.

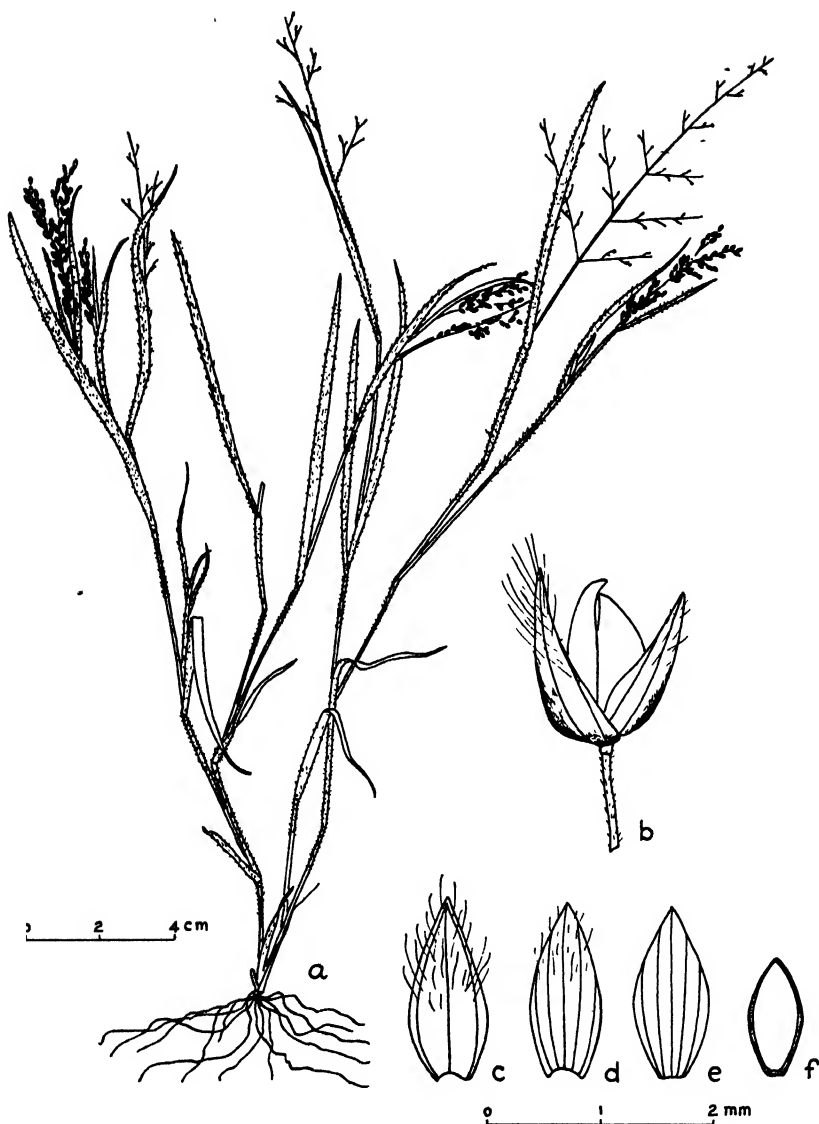


FIGURE 1.—*Panicum pellitoides*, new species: a, habit view of plant; b, spikelet; c, first glume, dorsal view; d, second glume, dorsal view; e, sterile lemma, dorsal view; f, floret.

The occurrence of this new plant in a plowed field merits further comment. It grew in a natural grassland, used for pasture. This area had been plowed only once, and the native grasses were still prominent in its vegetation. Hence the described habitat does not necessitate the conclusion that the plant is an introduced crop or weed. On the contrary, the grass seems definitely an endemic Hawaiian species, and finds its closest relative in another Hawaiian species of *Panicum*.

This new species is named in allusion to its resemblance to *P. pellitum* Trin, which is also Hawaiian. The available specimens show that it occurs on Maui and Molokai. The older species may be distinguished by the prominent ligule, of hairs about 1 mm. long; panicle branches ascending; spikelets 2-4 mm. long; glumes lanceolate, long acuminate; first glume long pilose on the upper part, hairs 1-2 mm. long; and fertile lemma 1.2-1.3 mm. long. In contrast, *P. pellitoides* has the ligule scarcely distinguishable from the general leaf pilosity, of hairs about 2 mm. long; panicle branches divaricate at maturity; spikelets 1.5-2.2 mm. long; glumes elliptic-ovate, acute; both glumes pilosulous on the upper part, hairs 0.5 mm. or less in length; and fertile lemma 1 mm. long.

FAMILY RUTACEAE

Zanthoxylum semiarticulatum St. John and Hosaka (fig. 2): in Degener, Fl. Hawaiiensis, Family 179, Dec. 15, 1932.

This species was described from material with fruit and with staminate flowers. Repeated trips to its known stations failed to produce material with pistillate flowers, so the plant was eventually published as a new species. Now it is possible to supply the lack in the original publication, as one branch with good pistillate flowers and several others with old flowers or young fruit were discovered in September 1933 at the South Opaëula Gulch locality.

Pistillate panicles oppositifolious, in anthesis 4-7 cm. long, 2.5-4 cm. in diameter, ovoid, minutely puberulous throughout; peduncles 2.5-3.5 cm. long; pedicels 3-5 mm. long, articulate at base; flowers with a sweet fragrance; calyx with 4 short broadly deltoid, minutely puberulous lobes; the 4 (or 5) petals unequal, 3.5-5 mm. long, oblong-ovate, one or more of them cucullate at tip, within white, with several longitudinal veins, without green, minutely puberulous, with several large, dark, internal glands, and many minute dots, the margins thin and whitish; ovary borne on a thick glandular and glutinous disk, body of the ovary asymmetric obovoid, green, closely glandular punctate; stigma depressed, subterminal.

Oahu: open moist woods, 1600 feet altitude, ridge south of South Opaëula Gulch, Paalaa, Koolau mountains, September 24, 1933. H. St. John no. 13339; also F. R. Fosberg no. 10313. The following collection, also from Oahu, is the first from the Waianae Mountains: small valley north of main ridge leading to summit, 2000 to 2700 feet, Puu Hapapa, July 30, 1933, W. B. Storey and Jack Dunn.

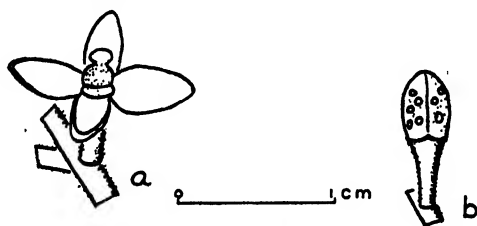


FIGURE 2.—*Zanthoxylum semiarticulatum* St. John and Hosaka: a, open pistillate flower; b, pistillate bud.

Zanthoxylum semiarticulatum is distinguished by its puberulent petiole, rhachis, and petiolules; lateral petiolules non-articulate; leaflets obtusely short-pointed; terminal leaflet 7-13.5 cm. long; staminate flowers with the calyx minutely puberulent, calyx lobes ovate-deltoid, becoming reflexed; petals 5-6 mm. long, white; anthers 1.5 mm. long; pistillate flowers with calyx lobes about 0.2 mm. long, membranous, broadly deltoid, minutely puberulous. The most nearly similar species is *Z. oahuense* Hillebrand, which is also a native of the mountains of Oahu. It differs in having the petiole, rhachis, and petiolules glabrous; petiolules all articulate at or above the middle; leaflets caudate acuminate; terminal leaflet 5-8 cm. long; staminate flowers with the calyx lobes rotate, shallow or merely undulate; petals 3-4.5 mm. long, greenish; anthers 0.8-1 mm. long; pistillate flowers with calyx lobes 1-1.2 mm. long, ovate, foliaceous, puberulent and ciliate. Complete pistillate flowers of *Z. oahuense* have not yet been collected.

FAMILY RUBIACEAE

Psychotria grandiflora Mann, Am. Acad. Arts Sci., Proc., vol. 7, p. 170, 1867.

Straussia grandiflora Caum, B. P. Bishop Mus., Occ. Papers, vol. 9, no. 5, pp. 9-10, pl. 7, 1930.

Careful examination and comparison of the type of *Straussia grandiflora* Caum reveals that it is really a *Psychotria* and that it is

identical with *Psychotria grandiflora* Mann. Mr. Caum tells me that the identity of the specific names was due to chance and that he had no thought of making a transfer.

FAMILY CUCURBITACEAE

Sicyos Hillebrandii St. John, new name.

Sicyos laciniatus Hillebrand, Fl. Hawaiian Is., p. 138, 1888; not *S. laciniata* Linnaeus, Sp. Pl., ed. 1, p. 1013, 1753.

SAMOAN PANDANACEAE

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SAMOAN PANDANACEAE

By

UGOLINO MARTELLI

INTRODUCTION

When Professor Karl Rechinger kindly asked me to study the family of Pandanaceae for his interesting works on the botany of Samoa, New Guinea, and the Solomon Islands,¹ I did not expect that after a relatively short time I should be writing again on the same subject, the Pandanaceae of Samoa. The numerous collections recently made by Mr. D. W. Garber and Dr. Erling Christophersen² of Bernice P. Bishop Museum and by Professor W. A. Setchell of the University of California offered opportunity for a revision of the species found in Samoa, or "Archipel des Navigateurs," as it was called by Bougainville (1768). I am glad to have had the opportunity of studying these collections, and I thank the collectors for the privilege. I am also grateful to the Director of Bernice P. Bishop Museum for having entrusted to me such an important collection.

I do not think it necessary to relate here the political or geographical history of Samoa. I will only call attention to the important work by Prof. W. A. Setchell,³ in which the vegetation of these islands is particularly well described.

The following pages do not complete the study of Samoan Pandanaceae, I am sure. The plants so far described are from Savaii, Upolu, Tutuila, Ofu, and Tau. I have seen no specimens from the small volcanic islands, Manono, Apolima, Fanuatapu, Namua, Nuutele, Nuula, Aunuu, and Olosenga, nor from Rose atoll. But I am sure that some different species or varieties of *Pandanus* must live there and would not wonder if some *Freycinetia* also might be found there.

Genus FREYCINETIA

Freycinetia Reinecki Warburg.

Folia 60 et ultra 100 cm. longa, prae floralia 2.5-3 cm., inferiora 5-5.5 cm. lata, late linearia, sensim attenuata, acuminata, versus basim paullo dentata et

¹ Rechinger, Karl, Botanische und Zoologische Ergebnisse wissenschaftlicher Forschungsreise nach den Samoa-Inseln. . . : Akad. Wiss. Wien, Denkschr., vol. 85, 1910. Plantae novae pacificae: Fedde Rep. Nov. Spec., vol. 4, p. 229, 1907.

² Christophersen, Erling, Flowering plants of Samoa, B. P. Bishop Mus., Bull., 1934.

³ Setchell, W. A., American Samoa: Carnegie Inst., Pub. 341, 1924.

amplectentia, utrinque longitudinaliter crebre venosa et in pagina inferiore \pm tessellata; folia, non praefloralia, in dimidia parte basilari utrinque valide tessellato—scaber, marginibus basim et ad apicem versus tantum minute denticulatis; costa media, in pagina inferiore filiforme basim versus evanescente, in dimidia superiori parte minute spinuloso-serrata; auriculis persistentibus, membranaceis, longissimis (etiam 13 cm.) 1-1.5 cm. latis ambitu convexo-lanceolatis, acutis, apice adnatis, late, remote et distincte transverse venatis, margine integribus. Inflorescentia mascula terminalis, magna, circiter 10 cm. terna plurimis spathis carnosus, acuminatis involuta; pedicellis 3.5 cm. longis, 5 mm. crassis, glabris, in sicco longitudinaliter striatulis, parte antherifera, cylindracea, 5 cm. longa, circiter 1 cm. crassa, addensata. Filamentis elongatis, 3 mm. filiformibus; antheris parvis (1 mm.), globoso-oblongis. Syncarpia terna vel quaterna (Warburg) bina (fide Christophersen), terminale; pedicellis 4.5-5 cm. elongatis, 3-5 (10 Warburg) mm. crassis, parte fructifera (syncarpio) multo elongata, strobiliforme, 7-9 cm. longa, 2.5-3 cm. crassa, numerosissimis baccis dense constructa. Baccae circiter 13 mm. longae, angustae, sublineares vix lagaeni-formes, cum parte seminifera succulenta, 5-6 mm. longa ad basim sita, parte sterile consistente, subaequilonga, apicem versus subcornea cum vertice capitato, circulare vel bilobo, supra plano, anulo latiusculo, laeve cinto. Stigmata bina, distincta vel interdum confluentia. Semina lineari-naviculaeformia, fere 2 mm. longa cum strophilo indistincto.

Tutuila: wireless trail, back of Pago Pago, Dec. 26, 1924, Garber, nos. 906 (male) and 907 (female). Upolu: Lake Lanuboo, altitude 700 meters (leaves only), Aug. 8, 1929, Christophersen, no. 127; forest, Malololelei, Lanutoo, altitude 700 meters, Aug. 5, 1929, Christophersen, no. 60. Savaii: forest above Matavanu, altitude 900 meters, Aug. 5, 1931, Christophersen, no. 2264.

A rather common species known to the natives as *ie-ie*. Reinecke collected it in different localities in Samoa, as is evident from his different field numbers: 255, 255a, 255b, 253, 362. All these specimens are female. No male plant was known before that collected by Garber. The leaves nearest the inflorescence differ from the lower ones in being wider and in having the blade distinctly transversely tessellated.

Freycinetia samoensis Warburg in Engler, Bot. Jahrb. 25, p. 579, pl. 8, fig. A.

Folia spathacea, cm. 70 circiter longa, in parte basilari dilatato-rotundata (5-6 cm.), ibique amplectentia, sensim in parte foliacea attenuato-acuminato-subulata, utrinque longitudinaliter crebre valide venata, in parte basilari transverse tessellata, marginibus et costa media, brevissime, minutissime, remotiuscule denticulatis; auriculis membranaceis, angustis, attenuato-acuminatis, persistentibus. Folia spathacea superiora basi non dilatato-rotundata, sed lata (7 cm.), coriacea crassiuscula (in sicco), sensim attenuato-acuminato-subulata, longitudinaliter crebre et valide venosa; marginibus et costa media, apice tantum,

sicut in foliis, denticulatis; spathae plurimae, crassae ?, coriaceae (in sicco), latae 8 cm. ovatae, acuminato-subulatae vel ovato-acutae, inferiores 25 cm. longae. Inflorescentia staminifera terminalis, quaterna, pedunculo brevi, pedicellis 4.5-5 cm. longis, 4-6 mm. crassis, levibus, parte staminifera densiflora, 7.5-9.5 cm. longa, cylindracea, 1-1.5 cm. circiter diam. filamentis brevibus, antheris latiusculis, oblongo-rotundatis.

Savaii: forest above Matavanu crater, altitude 800 meters, Sept. 23, 1929, Christophersen, no. 831; and altitude 900 meters, July 14, 1929, Christophersen, nos. 2058 and 2198. Upolu: forest, Malolo-lelei, Lanutoo, altitude 700 meters, August, 1929, Christophersen, nos. 61 and 401. Tutuila: top of Pioa, scrub forest, altitude 500 meters, Jan. 2, 1932, Christophersen no. 3495 (sterile). Tau: altitude 2200 feet, Jan. 28, 1922, Garber, no. 750.

Freycinetia samoensis was described from specimens collected on Tutuila by Reinecke. It seems to be rather widely distributed through Samoa. Until recently the male plant was unknown. The native name is *lau-ie-ie*.

Freycinetia hombronii Martelli in Rechinger, Wiss. Forschungsreise nach Samoa (1910) 56.

Scandens; caulis 5-10 mm. crassus, internodis brevibus, 7-12 mm. longis, in sicco longitudinaliter rugosis. Folia circiter 40 cm. longa, angusta, 10-18 mm. lata, sensim attenuato-acuminato-subulata, in parte basilaris canaliculata, amplexentia ceterum plana, longitudinaliter minute venosa; marginibus in parte basilaris et apicalis plus minusve parce et breviter serrato-denticulatis; costa media, in pagina inferiori tenuissima, parte basilaris excepta, remote et minute denticulata; auriculis membranaceis, subpersistentibus, 5-6 cm. longis, ambitu convexus, 1 cm. latis ad basim, sensim attenuato-acuminatis, apice adnatis. Inflorescentia cum pedunculo circiter 3 cm. longo, 4-8 mm. crasso, pedicellis 3-4 et etiam 7 (fide Christophersen), 2-3 cm. longis, 2 mm. crassis antice appplanatis, ad apicem spinuloso-scabridis et secundum angulos per totam longitudinem spinuloso-denticulatis. Syncarpia cylindracea, 4-5 cm. longa et 2 cm. in diametro (in forma cylindracea), vel subglobosa 1.5-2 vel 3 cm. in diametro; baccae numerosae sublagaeiformes, 7 mm. longae, pentagonae, parte libera 3 mm. longa sublignosa rotundato-rostrata parte seminifera succulenta connata, pentagona, costulata, cuneata; area stigmatifera circulari vel angulosa ab anulo corneo nitido cincta; stigmata confluentia 4-5; semina naviculaeformia recta.

Savaii: forest above Letui, altitude 1000 meters, Sept. 27, 1929, Christophersen, no. 736; forest on crater rim above Matavanu, altitude 1000 meters, July 15, 1931, Christophersen, no. 2017; Le To, above Salailua, wet forest, altitude 750 meters, Oct. 21, 1931, Christophersen, nos. 2898 (male) and 2945; same locality and collector, altitude 1200 to 1300 meters, September, 1931, no. 2750. Upolu:


forest ridge above Malololelei, Lanutoo trail, altitude 700 meters, Aug. 8, 1929, Christophersen, nos. 132, 196, and 403. Tutuila: ridge trail to radio station, back of Pago Pago, Dec. 26, 1924, Garber, no. 930.

The native name is *ie-ie laulilii*. The roots are used for fish traps.

Some years ago I saw for the first time in Paris Herbarium a sterile specimen of this plant collected by Mr. Hombroen in Samoa, and I judged it belonged to a different *Freycinetia* from all others known in those islands. I was confirmed in that opinion when I observed Rechinger's collections, although those specimens were sterile, too. Nevertheless I described them as a new species. Now among the rich collections made by Garber and Christophersen in Samoa there are some specimens of *Freycinetia Hombroenii* with well-developed fruits. As their syncarps are cylindrical or globose I was doubtful whether to consider them as two separate species, or one as a variety of the other; but as I could not see any other difference between them I thought it better to consider them as varieties. In no. 736 the syncarps are globose, not wide in diameter, but variable. On the contrary, in no. 132 they are cylindrical. The fruits of neither number are ripe. The specimens collected by Garber, no. 930, are particularly interesting, although sterile, as they show the differences between the leaves and auricles of the young branches and those of the fertile ones. On the young branches the leaves are wider and longer with auricles more developed.

Genus PANDANUS

Subgenus KEURA

Phalanges manifeste e  arpidiis \pm numerosis et elevatis formatae in circulo vel irregulariter dispositis. Stamina in columna subfasciculata vel racemosa constituta.

KEY TO SPECIES

Marginibus foliorum \pm ferociter armatis.

Phalanges latae
pyriformes vel
angustatae quasi
pedunculatae

5-6 cm. latae, 9 cm. longae, loculis 11-12

et stigmatis vix prominentibus.....1. *navigatorium*

Phalanges cla-
vato-pyriformes

3.5-4 cm. latae, 7.5 cm. longae, oculis 4-5
convexo pyramidatis a sulcis separatis.
Stigmata crassa multo prominentia.....**2. calostigma**
forma samoana

Phalanges
subprismaticae

3 cm. latae, 5 cm. longae, oculis 4-6
subaequalibus, rotundatis, paulo promi-
nentibus et a sulcis mediocriter profundis
separatis**3. scopulorum**
3 cm. in diametro, 7 cm. longae, longitu-
dinaliter acutae angulosae et sulculatae,
oculis 5-9, elevatis pyramidato-rotundatis.....**4. tutullaensis**

Phalanges
cuneato-
turbinatae

Lateribus longitudinaliter latis non acute
angulosis.
6 cm. longae, 3.5-4.5 cm. latae, oculis
5-6, quam digiti anularis crassis, ro-
tundatis paulo elevatis.....**5. salalluaensis**

Lateribus longitudinaliter plus-minus cre-
bre acute angulosi et canaliculati.
5 cm. longae, 3.5-4 cm. diam., oculis
7-8 quam digiti minoris crassis, sub-
pyramidatis paulo prominentibus
et a sulcis paulo profundis separatis.....**6. sabulorum**
6-7 cm. longae, 3-5 cm. latae, oculis
numerosis 9-14, digiti minoris crassis,
elevatis, rotundato-pyramidatis, acu-
tiusculis profunde separatis.....**7. tauensis**
5 cm. longae, 2.5-3 cm. latae, oculis
4-7, digiti minoris crassis, rotundatis
subprofunde separatis**8. upoluensis**

Valide longitudinaliter costulato
angulosae, 4 cm. longae, oculis
5-7 acute pyramidatis et a sulcis
profundissimis separatis.....**varietas angulosa**
Parvae 3.5 cm. longae, 9-12 cm.
crassae, oculis pusillis 2 a sulcis
profundis separatis**varietas minor**

Phalanges subpris-
matico-cuneatae
vel turbinatae

5 cm. longae, 2-3 cm. latae, oculis 5-7,
elevatis, pyramidatis, profunde et late
separatis, in disco latiusculo explanatis.....**9. turritile**
4-4.5 cm. longae, 2.5-3.5 cm. latae, oculis,
4-5, elevatis, pyramidatis acute angulosi
a sulcis profundis et late divis in disco
lato explanatis**10. lanutooensis**
Turbinatae forma A

Marginibus foliorum inermibus vel subinermibus vel cum

dentibus minutis acicularis11. *odoratissimus* varietas *savalensis*

Marginibus foliorum semper inermibus.....varietas *laevis*



PLATE 1.—Phalanges of *Pandanus navigatorum* Martelli. Reduced.

***Pandanus navigatorum* species nova (pls. 1, 9, 10).**

Arbor trunco nudo, ad basim aliquas radices subbreves fulcrantes emittente, candelabrifforme valide et longe plure ramoso, ramis robustis expansis divaricato-ascendentibus longe ramulosis. Folia erecto-incurva adulta valde coriacea 130 cm. circiter longa, 12 cm. lata (ad basim), sensim usque ad apicem attenuata, longe acuminato-subulata; marginibus dentato-serratis, dentibus haud crebribus, brevibus, acutis vel breviter in subula terminatis; costa media in pagina inferiore prominente, acuta, basim versus, longo tractu, inermi, dein plus minusve remotiuscule, breviter et minute denticulata; lamina in parte basilari paginae inferioris, transverse crebre et minute valide tessellata, deinsuper utrinque, sed praecipue in pagina inferiore, longitudinaliter crebre et minute venata, apicem versus, in pagina superiore, secundum margines et costulam, a lineis dentium inpressis e praefoliatione enatis longitudinaliter percursa. Syn-

carpium solitarium, cernuum, subglobosum, circiter 25 cm. in diametro plurimis phalangibus instructum. Phalanges pyriformes, e medio in base angustissima attenuatae, 9 cm. longae, 5-6 cm. latae, in dimidia superiore parte liberae, inter se adproximatae, ibique in toto subglobosae, pentagonae, irregulariter plus minusve acute angulosae; lateribus planis vel canaliculatis vel secundum loculorum suturas, a sulco plus minusve profundo, angusto, longitudinaliter usque vel ultra dimidio phalangis percursis; vertice phalangium convexiusculo, loculis numerosis 11-12, interioribus interdum multo minoribus, convexiusculis, rotundatis, paullo prominentibus, pentagonis, a sulcis superficialibus vel subprofundis, anguste separatis. Stigmata parva et paullo prominentia. Endocarpium osseum in dimidia superiore parte phalangis locatum, fere 2.5 cm, spissum, inferne truncatum, supra, in toto, rotundatum subpyramidatum, profunde irregulariter rimosum.

Savaii: open fern country, near Manase plantation, altitude 100 meters, Aug. 16, 1931, Christophersen, no. 2410.

Some years ago in the herbarium at Kew Gardens I observed a beautiful syncarp of a *Pandanus* sent in 1878 by Rev. S. J. Whitmee. On the label was written only "Pacific Islands." In 1878 Whitmee was in Samoa and sent to Kew Gardens some specimens of fruit, but made no note of the locality. So the native country of that *Pandanus* remained unknown to me, and I preferred to wait before describing the new species. Now I can do this, because among the *Pandanus* collected in Samoa by Christophersen I find the same species.

2. *Pandanus calostigma* Martelli forma **samoana** Martelli (pl. 2).

Phalanges longiores, quam in forma typica, 7.5 cm. longae, pyriforme-clavatae, sensim usque ad basim attenuatae, acute-angulosae, vertice convexo-rotundatae, loculis convexo-pyramidatis, latis, brevibus, a stigmate crasso, latissimo, prominenti superatis.

Ofu: Mafafa, coconut grove, May 26, 1925, Garber, no. 984.

I consider this a variety of the species which I described from Tubuai.⁴ It differs only in the greater length of the phalanges, which are almost as long as those of *P. carolinianus*; in being more club-shaped and a little more protracted; and in having more acute longitudinal corners, the apex less rounded, and the locules less deeply divided from each other.

3. *Pandanus scopulorum* Martelli (pl. 2).

Arbor 5 m. alta. Folia crasse coriacea, ultra 160 cm. longa, basim versus 10 cm. lata, sensim attenuata et acumen latiusculum, subulatum et longum protracta; in pagina inferiore, basim versus (in sicco), conspicue minute transverse venato-tessellata, deinsuper minute crebre sed leviter longitudinaliter venata; costa media prominente, acuta, praeter basim versus remotiuscule serrata, dentibus brevibus, marginibus, si basim versus excipias, creberrime serratis,

⁴ Martelli, Ugolino, *Pandanus*: Webbia, vol. 2, p. 428, 1908.

dentibus subbrevis, subulatis, basi incrassatis, in pagina superiore, e medio ad apicem, quatuor lineis dentium e praefoliatione enatis percurta, duobus secundum margines et duobus a latere costulae. Syncarpium oblongum, 28×21 cm., solitarium, cernuum, pedunculatum, numerosis phalangibus instructum. Phalanges subprismatico-cuneatae circiter 5 cm. longae, 30-42 mm. in diametro (ad verticem), in basim sensim attenuatae, lateribus latis, subplanis; parte libera brevissima; supra, in toto explanatae; loculis 4-6, subaequalibus, crassiusculis, parum prominentibus, a sulcis profundis separatis, rotundato-subangulosis, vertice in disco irregulari explanatis. Stigmata parvula, prominentia, subhypocrepiformia. Endocarpium osseum in media parte phalangis situm, circiter 2.5 cm. spissum, superne pyramidatum, dentatum, inferne subplanum; mesocarpium superum cum cavernis latis; inferum fibrosum.



PLATE 2.—Phalanges of *Pandanus*: 1-2, *P. calostigma* forma *samoana* Martelli; 3-5, *P. scopulorum* Martelli. Reduced.

Savaii: rocky shore between Puapua and Samalaeulu, Oct. 10, 1929, Christophersen, no. 912.

4. *Pandanus tutuilaensis* Martelli (pls. 3, 9, 10).

Arbor 5-6 m. alta, trunco nudo, superne collecto-ramosa, copiose foliosa ad apicem ramorum; foliis erectis, apicem reflexis. Syncarpium solitarium pendulum oblongum, 30 X 19 cm. Phalanges 7 cm. longae, plus minusve compressae, 3.5 cm. in diametro, 2.5-3 cm. crassae, basim versus attenuatae, in parte superiore, dimidio minus, liberae et prismaticae, vertice, in toto plano-convexae; lateribus subplanis, secundum suturas loculorum leviter sed late concavo-canaliculatis haud sulcatis; loculis 5-9 subaequalibus, latiusculis, elevatis, pyramidato-rotundatis, acute-angulosis, subprofunde at late separatis. Stigma parvum ad verticem loculorum, hypocrepicum. Endocarpium osseum in dimidia superiore parte phalangis, situm, superne late pyramidato-rotundatum, 3.5 cm. spissum laeviter fimbriatum; mesocarpium superum cum cavernis latis, medullosio-fibrosis; inferum fibrosum, 3 cm. longum.



PLATE 3.—Phalanges of *Pandanus*: 1-4, *P. tutuilaensis* Martelli; 5-8, *P. tauensis* Martelli. Reduced.

Savaii: open fern country, near Manase plantation, altitude 100 + meters, Aug. 16-18, 1929 and 1931, Christophersen, nos. 672 and

2409. Tutuila: Matafaau, Reinecke, no. 459 (in Boissier's herbarium, named *P. Reineckei* Warburg).

Of no. 2409 I have a syncarp; of no. 1971 one leaf only, as the syncarp of this number was lost in a fire. Of no. 1971 there is a photograph of the whole plant with fruit. I consider no. 1971 the same as no. 2409.

P. tutuilaensis resembles *P. Macfarlanei* of Tahiti, and perhaps it is only a peculiar Samoan form of it. In Boissier's herbarium, under the name *P. Reineckei* Warburg, I saw some phalanges collected in Tutuila by Dr. Reinecke (no. 459); but they are in no way related to *P. Reineckei* Warburg, which is a "Hombromia." These specimens are undoubtedly referable to *Keura*. I consider these phalanges belong to my *P. tutuilaensis*.

5. *Pandanus salailuaensis* Martelli (pl. 4).

Folia 180 cm. longa, 8 cm. lata, fere e dimidia apicali parte sensim attenuata et in longum flagellum terminata, coriacea; marginibus serratis, dentibus in parte basilarum folii, subdistantibus, ad basim incrassatis, in parte apicali subapproximatis; lamina utrinque crebre minute longitudinaliter venata et in parte apicali, paginae superioris, a 6 lineis, secundum margines et costam, dentibus impressis e praefoliatione enatis percursa; costa media, in pagina inferiore, acuta et prominente, basim versus, inerme, dein dentibus remotis, apicem versus crebrioribus, brevibus, subulatis, adpressis. Syncarpium oblongum, 18 X 21 cm. Phalanges numerosae, 6 cm. longae, 3.5-4.5 cm. latae (ad apicem), persaepe compressae, 2-2.5 cm. crassae, ambitu turbinatae vix convexae et sensim in basim, 1.5-2 cm. latam, attenuatae, fere in dimidia parte superiore liberae, superne planae; loculis perpauca, 5-6, quasi digiti anularis crassitudine, subaequalibus, rotundatis, subangulosis, inter se a sulcis vix profundis separatis; stigma minusculum haud prominulum, apicale; lateribus phalangium paullo conspicue longitudinaliter concavo-late-subcanaliculatis et secundum suturas druparum, in parte libera tantum, a sulco angusto notatis. Endocarpium osseum, in dimidia parte phalangis locatum, 2.5 cm. spissum, in sectione longitudinali, in toto, supra rotundato-pyramidatum, rimulosum, inferne excavatum. Mesocarpium utrinque fibrosum, 1.5 cm. spissum.

Savaii: rocky coast, Salailua to Lataitai, altitude about 5 meters, Sept. 18, 1931, Christophersen, no. 2656.

6. *Pandanus subulorum* Martelli (pl. 5).

Folia in surculum terminantia, chartaceo-subcoriacea, circiter 80 cm. longa, sensim attenuato-acuminata et in flagellum longiusculum protracta, 6 cm. lata; marginibus dentatis, dentibus brevibus, subulatis, erecto-subapproximatis; costa media, in pagina inferiore, prominente et acuta, basim versus, longo tractu, inerme, dein in primo minute et remotiuscule, apicem versus crebre, denticulato-serrata. Lamina utrinque, sed praecipue in pagina inferiore, validiuscule longitudinaliter venata, in dimidio apicali, in pagina superiore, sex lineis dentium, paullo conspicuis, impressis e praefoliatione enatis percursa. Syncarpium 14 cm.

longum, 15 cm. latum (fide Christophersen). Phalanges parviusculae, cuneatae, 5 cm. longae, 3.5-4 cm. latae (ad verticem), interdum compressae, 2 cm. crassae, sensim in basim (7-12 mm. latae) attenuatae, subprismaticae, vertice in toto leviter rotundatae; loculis 7-9, raro 5-6, mediocribus brevibus et paululum prominentibus, rotundato-subpyramidatis, sulcis manifestis sed vix profundis inter se separatis; lateribus phalangium subplanis, longitudinaliter laeviter concavo-subcanaliculatis, interdum, secundum suturas aliquarum druparum, in parte libera phalangis tantum, a sulco angustissimo percursis. Endocarpium osseum 24 mm. spissum, in dimidia superiore parte phalangis situm, oppositè bipyramidatum, supra truncatum et leviter rimulosum, inferne truncato-subexcavatum; mesocarpium superum breve, 9-12 mm. spissum cum cavernis rotundatis, mediocribus; infernum fibrosum, 15 mm. longum.

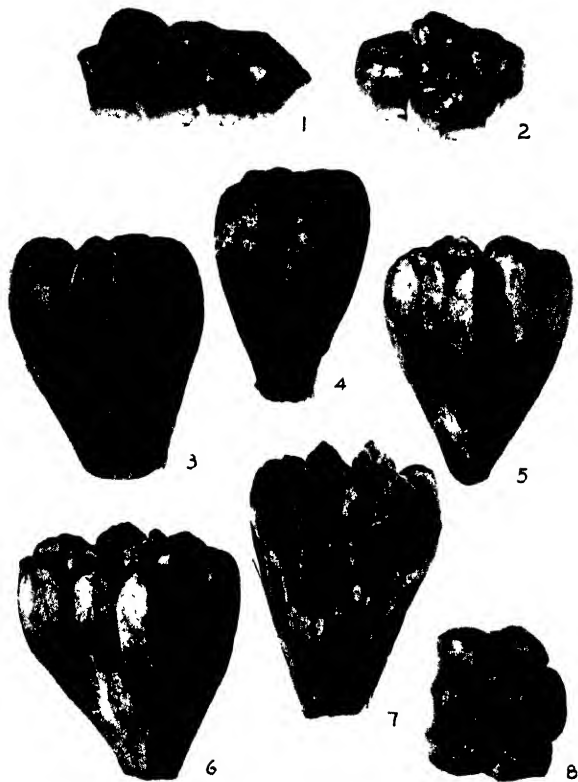


PLATE 4.—Phalanges of *Pandanus*: 1-5, *P. salailuaensis* Martelli; 6-8, *P. tauensis* Martelli. Reduced.

Savaii: sandy beach at Salailua to Lataitai, Sept. 18, 1931, Christophersen, no. 2657.

In the dimensions of the syncarp the collector has given the width greater than the length, which seems to me very strange.

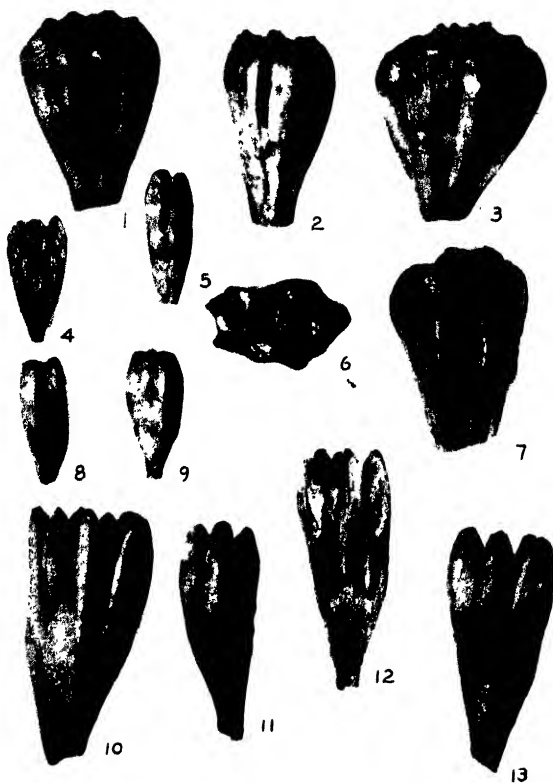


PLATE 5.—Phalanges of *Pandanus*: 1-3, 6-7, *P. subulorum* Martelli; 4-5, 8-9, *P. upoluensis* varietas *minor* Martelli; 10-13, *P. upoluensis* varietas *angulosa* Martelli. Reduced.

7. *Pandanus tauensis* Martelli (pls. 3, 4, 9).

Arbor 4-5 m. alta (vide Garber). Folia 1.5 cm. circiter longa, coriacea, 8-9 cm. lata (ad basim), sensim usque ad apicem in acumen longum, subulatum attenuata; marginibus dentatis, dentibus brevibus, satis dissitis, erectis; lamina, in parte basilar, utrinque transverse prominule tessellata, reliquum longitudinaliter minute venata, in pagina superiore et partis apicalis, lineis subinconspicuis longitudinalibus dentibus impressis, e praefoliatione enatis percursa; costa media, in pagina inferiore, acuta et prominente, basim versus, longo tractu, inermi dein irregulariter denticulata, dentibus remotis, brevibus, acicularibus, subadpressis. Syncarpium magnum, globosum, circiter 25 cm. diam. vel oblongum 22 X 24 cm. Phalanges numerosae, 6-7 cm. longae, 3-5 cm. latae (ad apicem),

compressae, 2-3 cm. crassae, cuneatae, sensim usque ad basim (circiter 1.5 cm. latam) attenuatae, in dimidia superiore parte liberae, vertice, in toto, subplanae; lateribus irregulariter valide et acute angulosis, canaliculatis et longitudinaliter usque ad dimidiam superiorem partem phalangis secundum suturas druparum a sulco angusto notatis; vertice in toto subplano. Loculis numerosis, 9-14, quam digito minimo crassis, rotundato-pyramidatis, vel pyramidatis elevatis et acutiusculis inter se profunde et late separatis. Stigma minutum apicale, prominulum. Endocarpium osseum, in dimidio vel vix in superiore parte phalangis situm, 3 cm. spissum et in sectione longitudinali, superne pyramidato-rotundato-fimbriatum, inferne excavatum vel subplanum. Mesocarpium superum cavernosum, cavernis oblongis, medullosa-fibrosis; inferum 2.5 cm. longum, compacto-fibrosum.

Savaii: open fern country near Manase plantation, altitude 100 meters, Aug. 16, 1931, Christophersen, no. 2411; rocky shore at Taga, Oct. 6, 1931, Christophersen, no. 2819. Tau: sandy beach at Faga, altitude 3 to 4 meters, Sept. 11, 1921, Garber, no. 665.

The native name is *lau paogo*.

In this species may be included Christophersen's no. 1854, of which I have seen a leaf and a photograph of the syncarp.

8. *Pandanus upoluensis* Martelli (pls. 6, 7).

Pandanus tectorius variety *upoluensis* in Rechinger, Bot. u. Zool.

Ergeb. v. Samoa, Neu-Guinea, u. Salomon Ins., p. 56, fig. 4, 1911; Webbia, Enum. Pand., vol. 4, tav. 17, figs. 11-13, tav. 18, figs. 4-19.

Savaii: Taga, rocky coast, altitude about 3 meters, Oct. 6, 1931, Christophersen, no. 2828; sea level, collected by a native, Leai, Nov. 16, 1929, nos. 669, 670, 671 (Christophersen), no. 670 from Fagamo, altitude not given.

Native names are *fala uli*, *fala toto*, *fala*.

It is a tree living on the coast on the recent lava flow. Setchell⁵ says he found this plant "on the 'taipupu,' or 'iron-bound' coast, forming a definite belt back of the Scaevola belt (or association)." Christophersen writes that the syncarp, not yet ripe, measures 17 by 16 cm.

Pandanus upoluensis varietas *angulosa* Martelli (pl. 5).

Phalanges acute-cuneatae et acute-angulosae, obscure et irregulariter pentagonae, 6 cm. longae, 16-32 mm. in diametro (ad apicem), forma druparum digiti minimi subtilior, longitudinaliter, clare conspicua; drupae 5-7, longitudinaliter acutiuscule angulosae, a caniculis plus minusve profundis et secundum suturas a sulco angustissimo notatae, apicem versus pyramidato-subrotundatae vel acutae, vertice in disco minusculo explanatae, inter se a sulcis profundis-

⁵ Setchell, W. A., American Samoa: Carnegie Inst. Pub. 341, p. 116, 1924.

simis angustis separatae. Stigmata apicalia, parvula, prominula, hypocrepea. Endocarpium osseum in dimidia superiore parte phalangis locatum, elongatum 27 mm. circiter, in sectione longitudinali, superne subpyramidatum, fimbriatum, inferne subconcauum; mesocarpium superum cavernosum, cavernis oblongis, angustis, 7-17 mm. longis, inferum fibrosum, circiter 25 mm. longum.

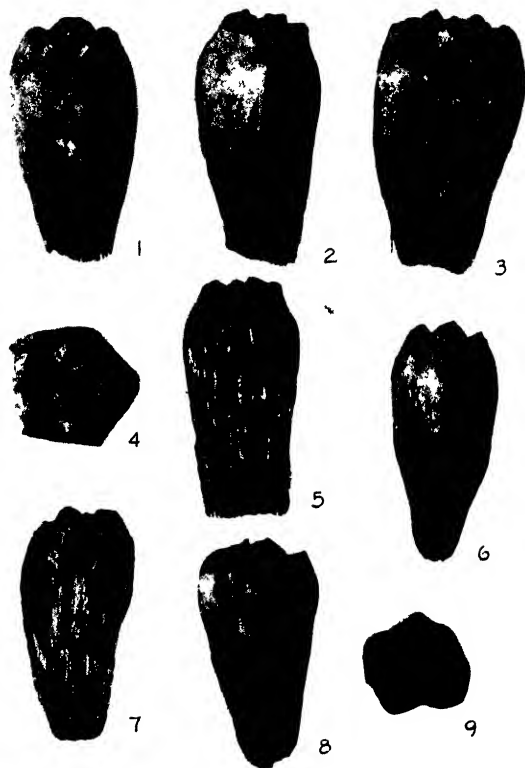


PLATE 6.—Phalanges of *Pandanus*: 1-5, *P. turritus* Martelli; 6-9, *P. upoluensis* Martelli. Reduced.

Savaii: Sili, cultivated, Nov. 13, 1931, Christophersen, no. 3131, from a necklace.

The phalanges of this specimen were found at Savaii by Christophersen, forming a necklace of a native, as also were those of *P. upoluensis* varietas *minor*. It is for that reason that the phalanges are pierced.

I think this *Pandanus* should not be separated from *P. upoluensis* except as a variety or form. The phalanges of *P. upoluensis* are very

variable in shape, examples of which I have in my herbarium. Very like the phalanges from Savaii are some collected on the island of Buka, of the Solomon Islands, by Prof. O. Warburg (no. 18133, Berlin Herbarium), and also some collected by Rechinger in New Britain (no. 3578). But the locules in the specimen from Savaii are more deeply separated from one another and are longer pyramidal. Also, on the sides of the phalanges and not extending below their upper half are very narrow, deep furrows.

***Pandanus upoluensis* varietas *minor* Martelli (pl. 5).**

Phalanges parvulae, 3-3.5 cm. longae, 9-12 mm. crassae, interdum compressae, subprismaticae, acute angulosae, basim versus angustatae, apice truncatae, loculis pusillis, 4-5 interdum 2, a sulco profundo separatis. Stigma apicale minimum. Endocarpium osseum in medio phalangis situm, circiter 1.5 cm. spissum; superne rotundatum, inferne truncatum; mesocarpium superum cum caveris parvis; inferum fibrosum.

Savaii: Sili, cultivated, Nov. 13, 1931, Christophersen, no. 3132, from a necklace.

This variety is very interesting and has a distinct feature, the phalanges being very small and thin. It looks so different from ordinary *P. upoluensis* that if I had not seen many intergrading specimens I would have considered it a different species. It grows also on Buka, one of the Solomon Islands. The phalanges described here formed a necklace worn by a native—a common use made of them in Polynesia. In the collections of the Botanical Museum at Berlin I saw a very interesting necklace of *Pandanus* fruits. Setchell has published a photograph of this ornament, which belongs to the species *P. upolucensis*, not to variety *minor* or *angulatus*.

9. *Pandanus turritus* Martelli (pls. 6, 7).

Folia 1-1.5 m. longa, 5.5-7 cm. lata, valde coriacea, sensim attenuata et longe acuminato-subulata, utrinque longitudinaliter crebre venata; costa media acuta et prominente, in parte basilari inermis, dein minute spinosa, apicem versus crebre minute serrata; marginibus basilariibus inermibus, caeteris serratis, dentibus brevibus, acicularis; in dimidia superiore parte paginae superioris a 6 lineis impressis dentium e prefoliatione longitudinaliter enatis percursa. Syncarpium globosum 16 × 16 cm. diam. Phalanges circiter 5-5.5 cm. longae, prismaticocuneatae, acute-angulosae, in tertia circiter superiore parte 2.5-3 cm. diam., ibique convexo pyramidato-truncatae, dehinc usque ad basim latiusculam sensim attenuatae lateribus latis, planis vel vix concavis; loculis 3-7 elevatis, inter se profunde et late separatis, pyramidatis, truncatis ad verticem in disco parviusculo explanatis. Stigmata parva haud vel vix prominentia. Endocarpium osseum in medio phalangis situm, fere 2 cm. spissum, superne, in sectione longitudinale late triangulare, apiculatum. Mesocarpium superum et inferum fibrosum.

Upolu: swamp near Tiavi, altitude 720 meters (empty phalanges), Aug. 12, 1929, Christophersen, no. 170; edge of Lake Lanutoo, altitude 700 meters, Aug. 8, 1929, Christophersen, nos. 120 and 121 (empty phalanges). Savaii: Sealetele, rocky coast, altitude 5 meters Aug. 22, 1931, Christophersen, no. 2473.

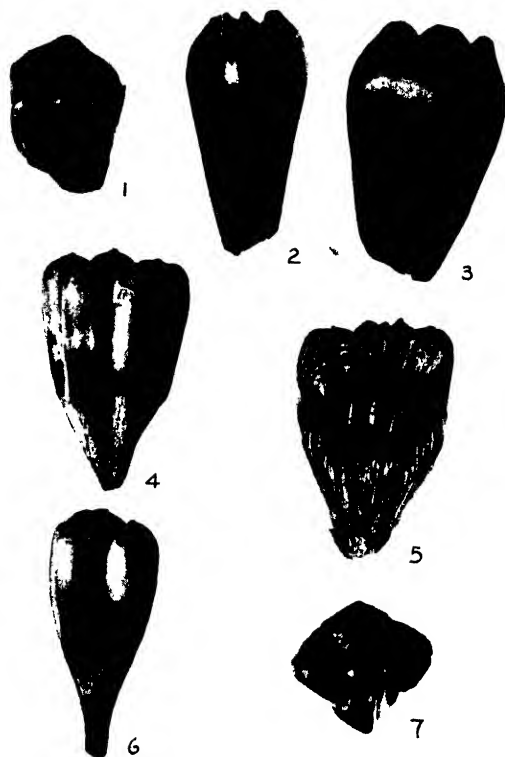


PLATE 7.—Phalanges of *Pandanus*: 1-3, *P. turritus* Martelli; 4-7, *P. upoluensis* Martelli. Reduced.

Closely related to *P. lanutooensis*. *P. turritus* lives at high elevations, at 700 meters, as is noted on the labels of specimens nos. 120, 121, and 170, all of which have empty but well-shaped phalanges. I am surprised to see the same species, Christophersen no. 2473, with well-developed phalanges, collected on Savaii on the rocky coast at an altitude of 5 meters; I suppose labels may have been mixed. I named this species *P. turritus* because the locules of the phalanges

stand up like small towers and look like a turreted crown. The native name is *lau fala*.



PLATE 8.—Phalanges of *Pandanus*: 1-6, 8, *P. lanutoensis* Martelli; 7, 9-12, *P. lanutoensis* forma *A* Martelli. Reduced.

10. *Pandanus lanutoensis* Martelli (pl. 8).

Arbor 2-5 m. alta. Folia sub-rigida, 1 m. circiter longa, crasse coriacea, ad basim 5-7 cm. lata, lanceolata sensim attenuata usque in longum acumen subulatum; lamina, imae basi, utrinque levia caeterum longitudinaliter creberrime minutissime sed (in sicco) manifeste venulosa; in pagina inferiore, basim versus, plus minusve transverse venulosa et tessellata; in dimidia apicali parte paginae superioris juxta margines et costam mediam a duobus lineis vix spectabilibus, impressionis dentium e praefoliatione enatis percursa; costa media sub-tus angusta, prominente et in tertia basilari inerme vel dentibus parvis, brevibus, acutis munita, caeterum minutissime dense et acute serrata; marginibus in parte basilari inermibus, dein minute dense serratis, dentibus brevissimis, subadpressis, acutis, rectis. Syncarpium solitarium globosum, 10 × 10 cm.; pha-

langes 4-4.5 cm. longae, turbinatae, subprismaticae acute angulosae; lateribus latis, subplanis, in tertia superiore parte liberae, in duobus inferioribus, ambitu vix convexo, connatae, sensim in basim latiusculam 2.5-3 cm. attenuatae, in parte superiore libera, ambitu rotundato, pyramidato-truncatae et in loculos, 4-5, plus minusve congestos protractae; loculis pyramidatis, acute angulosis, elevatis et a sulcis profundis plus minusve latis divisis; vertice loculorum explanato in disco lato anguloso, nitido. Stigmata hypocreptica, rotundata. Endocarpium in medio phalangis locatum, 19-21 mm. spissum, superne pyramidatum et profunde acute dentatum; mesocarpium crasse fibrosum.

Upolu: edge of Lake Lanutoo, altitude 700 meters, Aug. 21-22, 1929, Christophersen, nos. 381 and 382.

The native name is *fasa*.

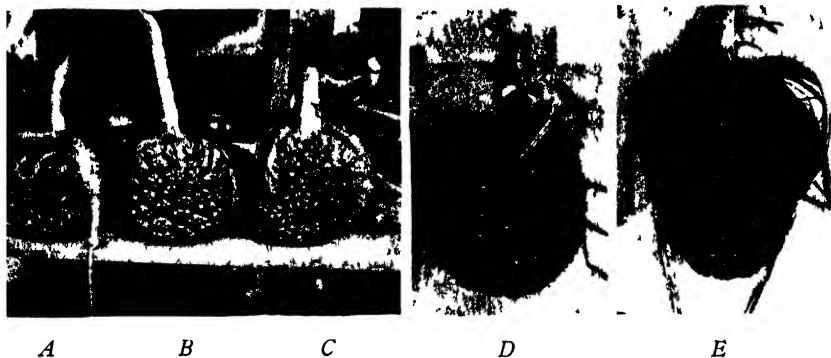


PLATE 9.—*Pandanus* fruits: A, *P. tutuilaensis* Martelli; B, *P. navigatorum* Martelli; C, *P. tauensis* Martelli; D, *P. Reineckei* Warburg; E, *P. tutuilaensis* Martelli. Reduced.

Pandanus lanutooensis forma A (pl. 8).

Phalanges obpyramidato-subturbinatae, ambitu convexo-rotundatae, acute tetra-pentagonae, lateribus latis, plano-convexiusculis e medio ad basim (6 mm. crassam), attenuatae et adnatae e medio ad verticem liberae, convexo-subrotundatae, 3-4 interdum 5 loculos parviusculos terminatae.

Upolu: Marau Plate ridge, above Saluafata, Sept. 4, 1929, Christophersen, no. 525.

The shape of the phalanges, rounded at the middle, distinguishes this variety from the type. In the same parcel with no. 525, I found some phalanges belonging to *P. upoluensis*, like those of no. 670, and a phalanx of *P. Reineckei*. The native name of form A is *paogo*.

11. ***Pandanus odoratissimus* varietas *savaiensis* Martelli.**

Pandanus tectorius varietas *savaiensis* Martelli in Rechinger, Bot. u. Zool. Ergeb. v. Samoa, New Guinea, u. Salomon Ins. 1911, p. 5, fig. 5, et Martelli in Webbia, Enumer. Pand., vol. 4, p. 1, tav. 16, figs. 4-7.

Savaii: Luma, sea level, cultivated, collected by Leai, Sept. 16, 1929, no. 662 (Christophersen); Taga, shore, forest, altitude over 5 meters, Oct. 6, 1931, Christophersen, no. 2829.



A



B

PLATE 10.—*Pandanus* trees: A, *P. tutuilaensis* Martelli; B, *P. navigatorum* Martelli.

The shape, consistency, venation, and other features of the leaves of these specimens are quite like those of the type collected by Rechinger. Only specimens collected by Leai differ in having the margins of the leaves finely toothed for their entire length. I suppose the armed form is wild and the unarmed form cultivated. Setchell says that he found this *Pandanus* along the shore, a "bush, about 2 meters high, growing with its roots submerged slightly at high water." The native name is *lau-ie*.

***Pandanus odoratissimus* varietas *laevis* (Warburg) Martelli.**

= *Pandanus tectorius* varietas *laevis* Warburg.

Savaii: Manase plantation, cultivated, Aug. 13, 1931, Christophersen, no. 2371, leaf only. Tau: sandy beach at Faga, Dec. 15, 1921, Garber, no. 665; tree 3 meters high.

The native name is *ie-toga*. Leaves are used for fine mats (Garber).

Subgenus HOMBRONIA

Phalanges biloculi 1-2 seriatim dispositi; stamina sine columna in rachis crassis peltatis dense conferta.

12. **Pandanus Reinecke** Warburg in Engl. Bot. Jahrb., p. 581, 1898.

Arbor 3-5 interdum etiam 8 m. alta. Folia 1-1.5 m. longa, crasse coriacea, basi 9-10 cm. lata, sensim attenuata usque ad apicem et in acumen angustum longum, robustiusculum terminata; lamina, basim versus utrinque, scabrida causa transverse crebre et crassiuscule venoso-tessellata, et praecipue in pagina inferiore longitudinaliter crebre venulosa, in pagina superiore, apicem versus secundum margines, lineis impressis dentium e praefoliatione enatis, percursa; marginibus in parte basilari inermibus, caetero creberrime subirregulariter dentatis, dentibus interdum robustis, ad basim incrassatis, adscendentibus, acutis vel subulatis, apicalibus brevissimis rectis; costa media in pagina inferiore angusta, prominente, acuta, in parte basilari inerme, dein remote et crasse dentata, caetero denticulata, dentibus erectis a marginalibus simillimis. Syncarpium solitarium, pendulum, globosum vel suboblongum, 14×17 vel 15×15 cm. vel oblongum 21×15 cm. Phalanges 4-6 cm. longae, mono-, bi-, vel tricarpidiae, 2-4 cm. latae, apice rotundatae, carpodia (loculis) a sulculo separata. Stigma superans, circiter 3 mm. longum a latere disci lati, plano-rhomboidei situm. Endocarpium osseum variable, saepe in parte mediana phalangis locatum, in sectione longitudinale elongatum, 3.5 cm., inferne cuneatum, basi subtruncatum, superne in pyramidem centralem longam productum. Mesocarpium superum cum cavernis latiusculis spongioso-fibrosi; inferum fibrosum.

Tutuila: top of S. Pioa, forest, Sept. 10, 1929, Christophersen, no. 1219; Matafao ridge, forest, altitude 500 meters, Dec., 1929, Christophersen, no. 1022. Savaii: forest above Matavanu, altitude 900 meters, July 14, 1931, Christophersen, no. 2059; Mataaga, swampy place in forest, altitude 1,000 meters, Sept. 15, 1929, Christophersen, no. 625; Mataulanu lake, altitude 900 meters, Oct. 3, 1929, Christophersen, no. 861. Upolu: swamp near Tiavi, altitude 720 meters, Aug. 12, 1929, Christophersen, no. 169.

This is the *Pandanus* which, according to Setchell, forms "a conspicuous association on the overhanging edge of a ridge about 535 to 540 meters altitude. This ridge came to be known to our party as 'Pandanus Ridge.'" It seems to be confined to high elevations, between 550 and 1,000 meters. The native name is *paogo*.

Subgenus CORONATI

Phalanges obscure pluricarpidiae; stigmata infra apice prominenter in columna disposita.

13. **Pandanus Whitmeeanus** Martelli in Webbia, vol. 1, p. 364, 1905, et Enumer. Pan. in Webbia, vol. 4, pt. 1, tav. 22, figs. 4-6, 1913.

Folia 180 cm. et etiam (fide Christophersen), 3 m. longa, 10 cm. circiter lata (ad basim), loriformia, apicem sensim attenuato-longe acuminato-subulata, haud flagellifera, coriacea, pagina inferiore, in parte basilari, laeve, in superiore punctis alveolatis crebre sparse conspersa; lamina utrinque longitudinaliter crebre minuteque venata, basim versus interdum, brevi tractu, secundum margines tantum minute sed prominule transverse tessellata, a plicis lateralibus longitudinaliter, submanifestis percursa, plicis, in parte extrema apicali, denticulatis; costa media in parte basilari, paginae inferioris, evanescente, dein lata, inerme in parte apicali lineari, acuta et prominente, fere in dimidia superiore parte tantum crebre minute et acute serrata; marginibus laminae in parte extrema basilari inermibus et angustissime membranaceo-alatis, deinsuper acute serratis, dentibus acutis, brevibus, interdum, in parte basilari, curvo-ascendentibus. Drupae 7 cm. longae, fere 3.5 cm. latae, 2.5 cm. crassae, plus minus compressae, oblongae, basi sensim attenuatae, acute exagonae, apice explanatae. Stigmata plurima (6-8) circum et infra marginem areolae terminalis lateraliter radiatim disposita, sessilia, plana, elliptica, 5 mm. longa, 2 mm. lata. Pars mesocarpica superseminalis plena, medullosa-fibrosa, 3 cm. lata, 2.5 cm. longa; endocarpium lapideum subcentrale totam latitudinem drupae tenens.

Savaii: Safotu, cultivated, Sept., 1931, Christophersen and E. Stehlin, no. 3597. Tutuila: top of Pioa, scrub forest, altitude 500 meters, Jan. 2, 1932, Christophersen, no. 3580.

SPECIES EXCLUDENDA

- Pandanus samoensis** Warburg in Engl. Bot. Jahrb., 1893, p. 580, pl. 8, C, et Pflanzenr., p. 73, 1900.

Warburg established his *P. samoensis* from a specimen collected in 1894 at Vailele, Upolu, by Dr. F. Reinecke. As the spadix is so young that the features of the fruit are not sufficiently developed, the author judged it belongs to the subgenus *Lophostigma*. The male flowers, which he found with the same specimen, he rightly judged belong to the subgenus *Keura*, probably to *P. tectorius*, and supposed that they may have been mixed in the collection. I saw the type specimen in the Botanical Museum in Berlin, and I am sure that no confusion took place there. For male and female flowers belong to the same species, and they do not belong to *Lophostigma* but to *Keura*.

The figure (Warburg in Jahrb., 1878, pl. 8, C) shows very clearly that the structure of the stigma is that of a young *Keura* and not of a *Lophostigma*. Besides, the figure shows the upper part only of a

drupe. If present, the lower part would show the multiple formation of phalanx, and this, I was able to confirm on examining the type specimen. It seems to me that when ripe the phalanges of *P. samoensis* Warburg must have locules deeply separated, almost like those of *P. upoluensis* varietas *angulosa*.

I think *P. samoensis* Warburg is a *Keura*, probably *P. upoluensis*; but I think it better to leave it as an undefinable name.

PARTULIDAE OF TONGA AND RELATED FORMS

By

HENRY A. PILSBRY and C. MONTAGUE COOKE, Jr.

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PARTULIDAE OF TONGA AND RELATED FORMS

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INTRODUCTION

Tree snails of the family Partulidae are distributed so widely in Polynesia and Melanesia that they offer excellent clues for tracing the affinities and lineage of the insular faunas. The receipt of two species of this family from the island of Eua has given an opportunity for consideration of the filiations of the Tongan Partulidae. None were previously known from these islands.

Relationships in the Partulidae can only be determined approximately at present for the reason that the family has been classified upon the basis of shell characters, which are not fundamental as guides to phylogeny. Hitherto the anatomy has been worked out only in a few Society Islands species referable to the subgenus of *Partula*. By utilizing abundant material recently received at Bernice P. Bishop Museum it has been possible to overcome this handicap, so far as Tongan species are concerned, by studies of the anatomy of species of the neighboring Samoan and Fijian islands, together with some further information of the Society Islands species.

The chief anatomic differentiation of the family appears to be in the structure of the penis, which is remarkably varied in the several groups which we are now recognizing as genera.

In the pallial complex we have not found any constant differences between the genera. The shape and length of the kidney vary among the Partulidae, but the variations do not appear to have more than specific significance in the material we have gone over. The lung may be either immaculate or plain in some groups; *Samoana canalis* has it profusely marbled with black, and *Samoana conica* has no maculation.

The jaw and teeth seem to be very conservative throughout the family. No significant differentiation has been observed among the species belonging to *Partula* sensu stricto, *Thakombaua*, *Melanesica*, *Samoana*, *Eua*, and *Marianella* investigated by Binney, Heyne-mann, Semper, Thiele, and Pilsbry and Cooke.

DESCRIPTION OF TONGAN SPECIES

Genus *EUA*, new genus

Eua is pronounced in three syllables, the stress on the penultimate.

The shell is globose-conic or oblong-conic, of a few ($4\frac{1}{2}$) whorls, moderately to very widely umbilicate, spirally striate, not glossy; all the known species are dextral. The short penis contains a fleshy ridge as long as the cavity, adnate along one side, its free edge folded over. The retractor muscle and the *vas deferens* are terminal, the *vas deferens* passing directly forward to the base of the penis. The spermatheca is of medium length. The posterior prostate gland, the lung, teeth, and jaw are as in *Partula*. Type, *Eua globosa*, new species. Distribution, Tonga and Samoa.



FIGURE 1.—*Eua globosa*, new species, enlarged.

The typical subgenus of *Eua* is characterized by the globosely conic, widely umbilicate shell, which is strongly striate spirally and is unicolored.

***Eua globosa*, new species (figs. 1, 2, 3, a-c).**

The shell is globose-conic, broadly umbilicate, moderately thin, uniform pale buff (between cream and cartridge-buff), nearly lusterless. The spire of $4\frac{1}{2}$ whorls is short, terminating in an obtuse apex with a rather deep dimple. The whorls are strongly convex, the last ample, globose. The umbilicus opens broadly in the last whorl but is quite narrow in those preceding. Sculpture of close spiral lines weak on the first whorl (where they are generally worn and faint in adult shells), very deeply engraved on the rest of the embryonic shells of $2\frac{1}{2}$ whorls. They become coarser on the post-embryonic whorls, and on the upper half of the last whorl have the appearance of coarse but very weak spiral cords; below the periphery they are irregular, smaller, subobsolete or often scarcely discernible. These spirals are crossed by very fine, irregular, crowded axial striae on the spire and low wrinkles on the last whorl. The aperture is

broad, shortly ovate, white. The white peristome is expanded, slightly thickened within. The columellar margin is built forward, and joined to the outer margin by a short, white parietal callus.

Length	Diameter	Length, aperture
22.3 mm	20.0 mm	13.5 mm
22.0 mm	19.5 mm	13.3 mm
21.6 mm	19.8 mm	13.2 mm

Bugai, Eua, altitude 300 feet, cotypes no. 115426 (B. P. Bishop Mus.) and no. 162130 (Acad. Nat. Sci. Phila.), A. Powell. Eua, the island at the southernmost end of Tonga, is $12\frac{1}{4}$ miles long, $4\frac{1}{2}$ miles wide, and attains a maximum elevation of 960 feet. As described by J. Edward Hoffmeister (B. P. Bishop Mus., Bull. 96, 1932), it is composed of a nucleus of volcanic material on which late Tertiary limestone has been deposited, but there are considerable areas of Eocene limestone and of volcanic rocks.

The foot (in alcohol) of *E. globosa* is a uniform gray color. Sole undivided. Upper surface is rather coarsely and deeply reticulate, the warts polygonal to oval, those along the foot edge lengthened. The tail is depressed.

The mantle is wide, broadly reflected all around. There is a very small body lobe behind the pneumostome, and the weak trace of another before it. Within the shell the mantle lining the upper whorls is largely white.

The lung (fig. 2, *c*) is rather short and wide, the transparent outer wall more or less profusely maculate with black and having many opaque silvery spots or ragged patches of minute white dots (outlined in the figure). No venation is visible except the vein leading to the heart, which is faintly seen. The kidney is triangular posteriorly, with an equally long extension forward, simulating a ureter, with lateral orifice at the end. There is no ridge or thread running backward from the orifice. The pericardium is equal in length to the triangular portion of the kidney.

The reproductive organs (fig. 3, *a-c*). The spermoviduct is closely convoluted as usual. A talon appears to be wanting as in all Partulidae. The prostate gland is short and posterior. The *vas deferens* adheres closely to the uterus, where it is wide but not glandular. The uterine part of the oviduct is, in the individual figured, much distended over two embryos, the walls there being as thin as tissue paper. The largest embryo has a shell 7 mm long, of $2\frac{1}{2}$ whorls, with narrow umbilical perforation. The vagina has mus-

cular walls, ribbed within. The spermatheca is oblong, with a slender duct of medium length, the whole 13.5 mm long. The penis is short (5.3 mm), wide, with the *vas deferens* and the retractor muscle inserted together at one side of the blunt end. The retractor is inserted posteriorly on the lung floor and is 7 mm long. The thin-

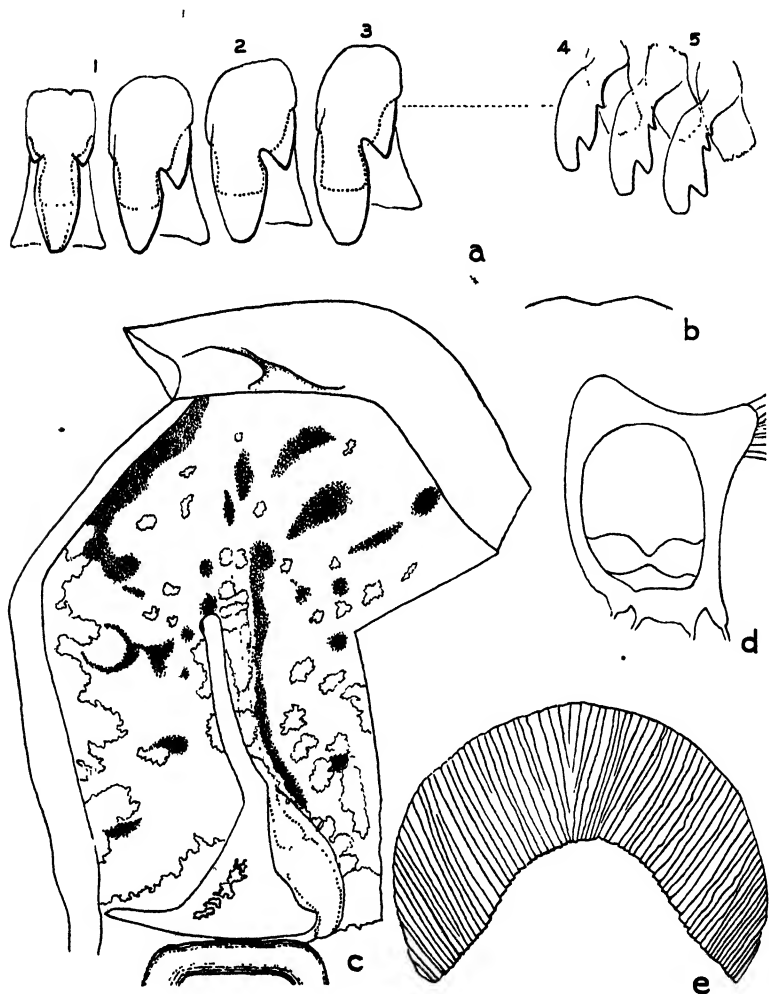


FIGURE 2.—*Eua globosa*, new species: a, central, lateral, and marginal teeth; b, contour of transverse row of teeth; c, pallial organs; d, outline of central nervous system; e, jaw.

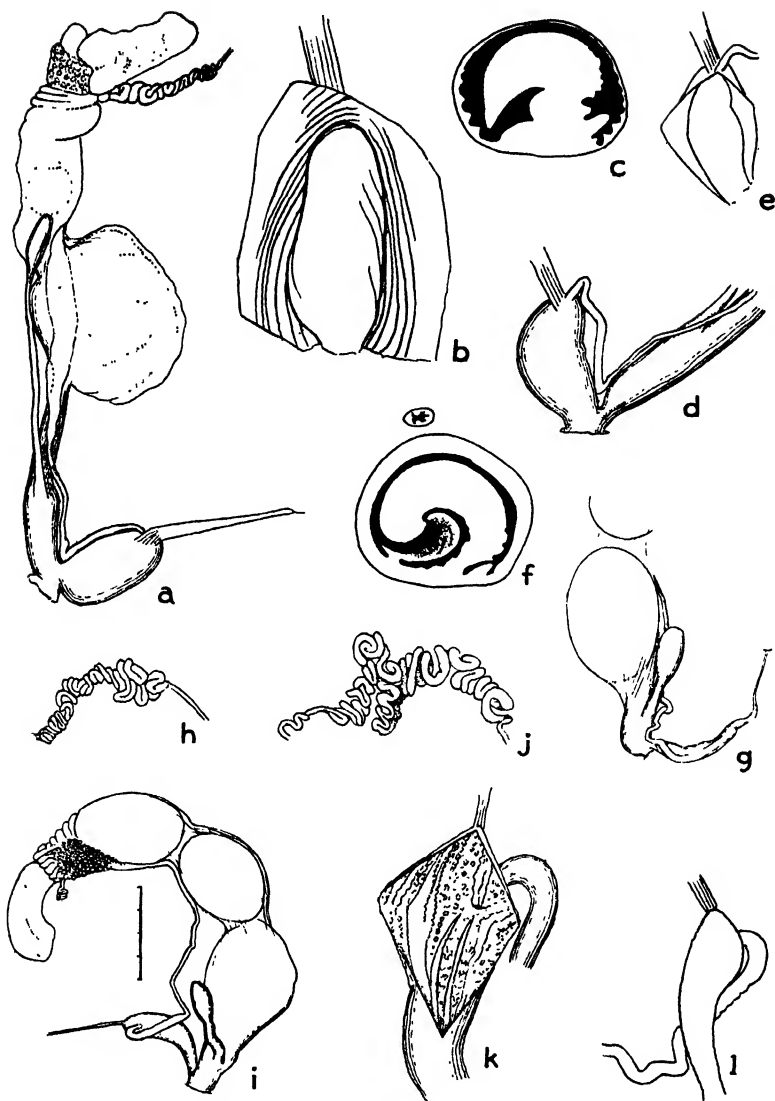


FIGURE 3.—Reproductive organs. *a-c*, *Eua globosa*, new species: *a*, organs of reproduction from above; *b*, penis opened; *c*, transverse section about midway of penis. *d-f*, *Eua zebrina* (Gould): *d*, terminal ducts of genitalia, lower side; *e*, penis opened (diagrammatic); *f*, section of penis. *g-h*, *Partula lanceolata* Cooke and Crampton: *g*, anterior ducts of genitalia; *h*, part of ovisperm duct. *i-l*, *Partula lirata* Mousson: *i*, organs of reproduction, lower side; *j*, part of ovisperm duct; *k*, penis opened near distal end, *vas deferens* on right; *l*, penis from above.

walled penis sac is almost filled by a fleshy ridge extending from end to end, adnate to one side throughout, its edge recurved, as in figure 3, *b*. The cavity formed by the folded ridge receives the *vas deferens* at the apex of the penis. The outer wall of the penis is longitudinally plicate in the vicinity of the ridge, the folds extending somewhat upon the latter (fig. 3, *b*, *c*).

The jaw (fig. 2, *e*) is thin, strongly arched, composed of many (80-85) narrow plaits with slightly irregular free edges, the plaits converging downward, leaving in the middle several short ones, as in *Drymaeus*. It is somewhat asymmetrical, having 45 plaits on one side, 36 on the other in the jaw figured.

The radula has thrice-bent transverse rows (fig. 2, *b*), the lines of lateral teeth running forward, those of marginals backward. There are about 23, 16, 1, 16, 23 teeth. The centrals are slightly narrower than the laterals, tricuspid, the mesocone slightly surpassing the basal plate, the ectocones smaller than in the lateral teeth. The laterals have long, blunt mesocones and large ectocones. The marginal teeth are oblique, tricuspid, the third cusp small, rarely doubled (fig. 2, *a*).

The central nervous system is drawn in figure 2, *d*. The cerebral ganglia are united by a long commissure. The visceral ganglia are conrescent into one lobed mass.

The small white dots in the mantle, the neurilemma, etc., are oblong, about 50 μ long, and are evidently calcareous, as they effervesce with acid. They are much less profusely spread in some individuals than in others, the calcareous material stored in the granules possibly having been used in forming the shells of embryos. All Partulidae examined possess these calcareous granules.

Genus SAMOANA Pilsbry

Samoana cramptoni, new species (figs. 4, *a*, *b*; 5, *f*; 6, *a-c*; 8, *a*; 9, *g*).

The shell is narrow, umbilicate and rimate, oblong-conic, thin, isabella color fading to cream below the summit, with a chestnut band at the periphery and narrowly showing above the suture in its last two turns. Surface rather glossy, the first whorl worn, the next $1\frac{1}{2}$ whorls having finely engraved spiral lines in the upper half; last 3 whorls with weak, fine wrinkles of growth but no spiral lines except on the base, where a few weak spirals are visible. The apex is rather obtuse. The whorls are rather strongly convex, the last very shortly ascending in front to the upper edge of the band. The small aperture is nearly vertical, shortly oval, slightly beveled and showing the band within. The peri-

stome is faintly flesh-tinted, narrowly expanded, subreflected, dilated at the columella, which, in an oblique view in the mouth, is slightly convex.

Length	Diameter	Aperture, length	Whorls
19.0 mm	10.5 mm	4.3 mm	5 1/3
18.5 mm	10.5 mm	4.0 mm	5 1/3

Eua, cotypes no. 118453 (B. P. Bishop Mus.) and no. 162332 (Acad. Nat. Sci. Phila.).

We take great pleasure in naming this species for Professor H. E. Crampton. It is not closely related to any of the known forms of *Samoana* but stands nearer to the Samoan species than to the Fijian *S. alabastrina*. It is the only *Samoana* having a band of any color markings. Under the microscope some traces of punctuation are seen in the engraved lines of the second and third whorls.

The lung (fig. 5, *f*) is 20 mm long, opaque, chalky white with some small, scattered, angular black spots, chiefly anteriorly. The triangular posterior part of the kidney is about one fourth of its length.

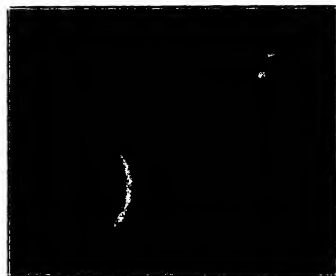


FIGURE 4.—*Samoana cramptoni*, new species, enlarged.

The reproductive system (fig. 6, *a-c*) has the usual short, stout penis of the genus, containing a large longitudinal ridge with folded-over edge (fig. 6, *b, c*). The epiphallus (figs. 6, *a*; 9, *g*) is longer than the penis, with a terminal retractor, which also continues weakly to the apex of the penis. The *vas deferens* enters a short distance below the end of the epiphallus. The duct of the spermatheca is longer than in any partulid snail examined, being nearly as long as the oviduct. The eggs (fig. 8, *a*) are oblong and flattened, measuring 4.2 by 3.4 by 2.8 mm.

The right ocular retractor passes between the branches of the genitalia as usual.

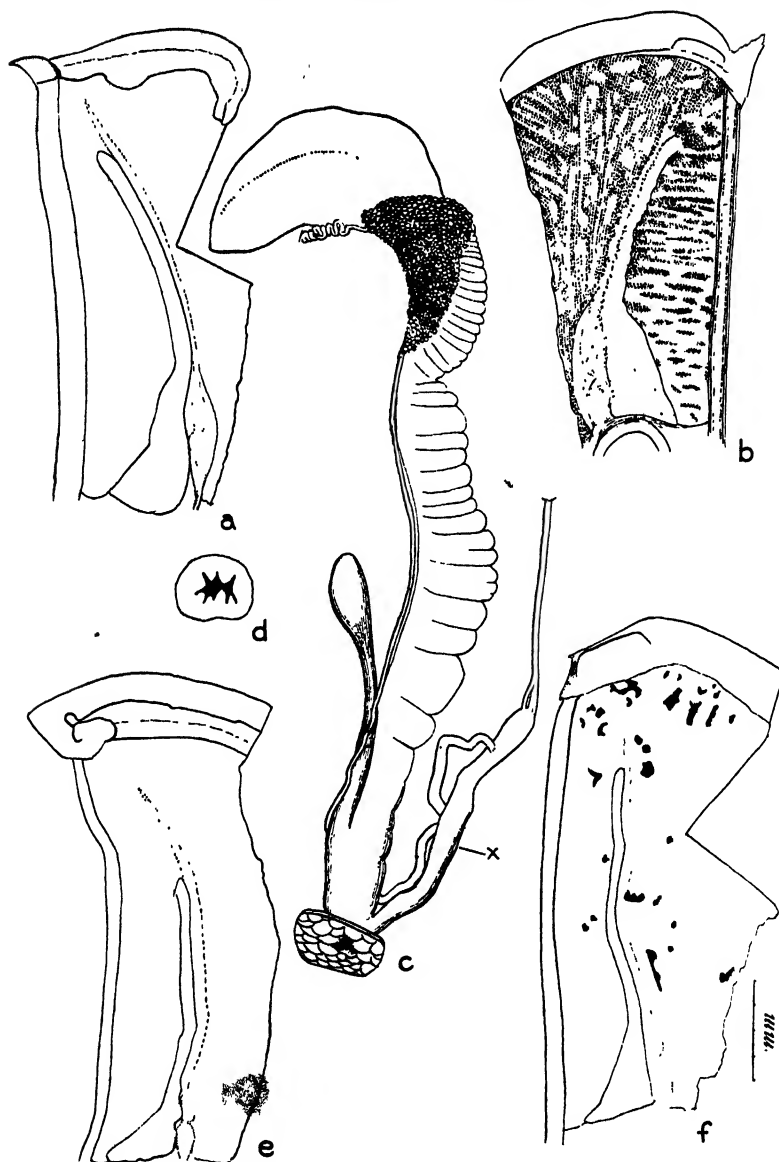


FIGURE 5.—Pallial and reproductive organs. *a*, *Partula lanceolata* Cooke and Crampton, pallial organs. *b*, *Samoana canalis* (Mousson), pallial organs. *c-d*, *Partula turneri perstrigata* Pilsbry: *c*, reproductive system from above; *d*, transverse section of penis at point marked *x* in figure 5, *c*; *e*, *Partula faba* (Gmelin), pallial organs. *f*, *Samoana cramptoni*, new species, pallial organs.

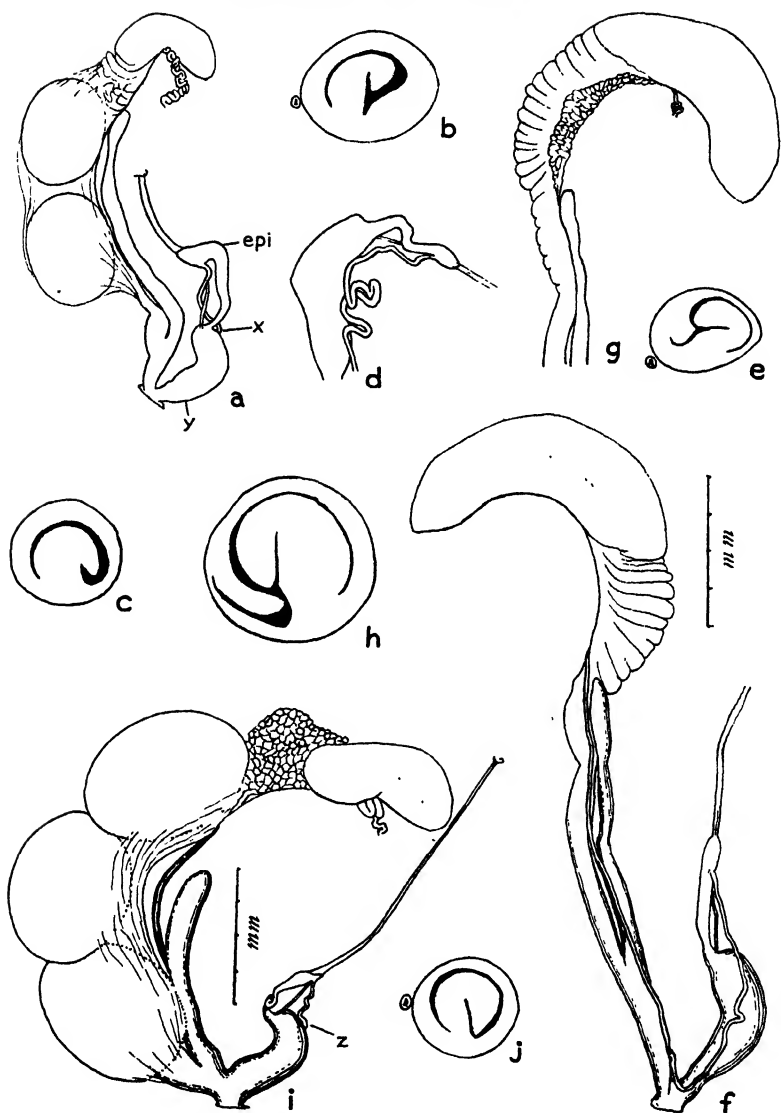


FIGURE 6.—Reproductive organs. *a-c*, *Samoana cramptoni*, new species: *a*, reproductive organs from above; *b*, *c*, transverse sections of penis at points *x* and *y* in figure 6, *a*. *d-e*, *Samoana canalis* (Mousson): *d*, penis, epiphallus, and part of *vas deferens*; *e*, transverse section of penis. *f-h*, *Samoana conica* (Gould): *f*, reproductive organs from above; *g*, posterior organs seen from below, showing prostate gland; *h*, transverse section of penis. *i-j*, *Samoana alabastrina* (Pfeiffer): *i*, reproductive organs from above; *j*, transverse section of penis at *x* in figure 6, *i*.

NOTES ON ANATOMY

Genus *PARTULA* Férussac

In *Partulae* of the Society Islands belonging to the typical sub-genus the cavity of the penis is divided into upper and lower sections by a difference in the sculpture of its walls, the upper part possessing densely papillose, irregular ridges (fig. 7, *d, g-i*), the lower part with strong longitudinal folds (fig. 7, *e, h, j*). At the junction of these two patterns is a more or less conspicuous constriction of the sac externally, as in figure 7, *b*.

The genotype, *P. faba* (Gmelin), from Opuia valley, Raiatea, no. 81723 (B. P. Bishop Mus.) (fig. 7, *a-e*), has some irregular folds in the densely papillose upper portion, as in figure 7, *e*, and there is a lateral sac or pocket where the *vas deferens* enters, shown in the two outlines of the penis (fig. 7, *b, c*). The large spermatheca and its duct are 14 mm long. The specimen drawn contained two eggs and one embryo of more than two whorls.

In *P. rosea* Broderip, from Huahine, no. 72012 (Acad. Nat. Sci. Phila.), one side of the upper section of the penis has greatly thickened fleshy ribs (fig. 7, *h, j*). In a species sent by Garrett without the shell (fig. 7, *f, g*) the same side has a chevron of oblique ridges. In both species the *vas deferens* enters the penis sac in a thin-walled side opposite these thickenings and at the distal third or fourth of the length of the penis, not at the end. The penial retractor muscle is terminal. The short duct of the spermatheca is swollen basally in these species.

This structure of the penis is entirely unlike what we found in *Eua*, where the penis is not divided into diverse upper and lower sections; no part has papillose walls, and the *vas deferens* enters terminally, near the penial retractor, and is received in the fold of the fleshy ridge which occupies the whole length of the penis sac. This differs so radically from *Partula* proper that we believe a different genus is indicated.

W. G. Binney (Acad. Nat. Sci. Phila., Proc., pl. 19, 1875) has figured the reproductive organs of *Partula bilineata*, *fusca*, *virginea*, *umbilicata*, and an undetermined species. The figures, made 60 years ago, are crude; but all agree in showing the penis constricted

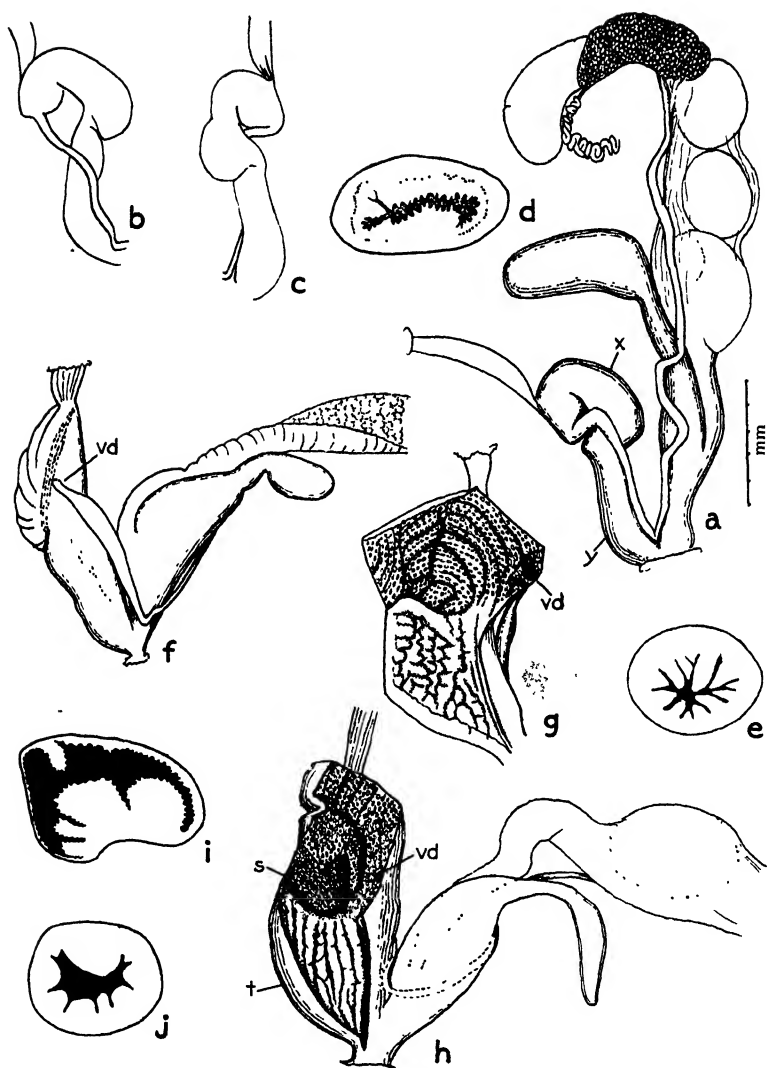


FIGURE 7.—Reproductive organs. *a-e*, *Partula faba* (Gmelin): *a*, reproductive system from below; *b*, *c*, two outlines of penis to show constriction; *d*, *e*, transverse sections of penis at *x* and *y*. *f-g*, *Partula*, undetermined species, anterior part of reproductive organs; *vd.*, *vas deferens* where it enters the penis; *g*, penis opened, *vas deferens* on right. *h-j*, *Partula rosea* Broderip: *h*, anterior part of reproductive system; *vd.*, pore where *vas deferens* enters penis; *i*, *j*, transverse sections of penis at points *s* and *t* in figure 7, *h*.

mesially, with the retractor muscle terminal and the *vas deferens* entering some distance before the end.

In *P. virginea* the constriction of the penis is represented as very long, with the upper portion slender, so that Binney questioned whether it might not be a modified part of the *vas deferens*. As figured, the structure appears to be very much like the epiphallus of *Samoana*, and a point requiring further investigation is whether what we are calling the epiphallus in *Samoana* is not homologous with the distal part of the penis in Society Islands *Partulae*. The question has taxonomic as well as morphologic interest, but it cannot be settled until the penis of *P. virginea* can be opened and a full comparison with that of the *Samoanae* made. A thorough study of the anatomy of the great and varied Society Islands series is much needed.

In the Melanesian *Partulae* the penis has no median constriction such as characterizes those of the Society Islands; but only three species have been dissected, and for the present we leave them in the genus *Partula*, subgenera *Thakombaua* and *Melanesica*.

Partula (Thakombaua) lirata Mousson (fig. 3, *i-l*).

Fiji: Mango Island, Lau Archipelago, no. 78936 B. P. Bishop Mus.), E. H. Bryan, Jr.

The penis is club-shaped with terminal retractor, the *vas deferens* entering a short distance forward of the end. Internally it has irregular ridges and papillae in the posterior part, becoming somewhat more strongly plicate lengthwise anteriorly. The *vas deferens* is somewhat enlarged in the part lying along the penis. The oblong spermatheca is about as long as its duct, the whole being shorter in this species and *P. lanceolata* than in any other Partulidae examined. The ovisperm duct is remarkably knotted (fig. 3, *j*). The uterus contained three oblong eggs measuring 3 by 4.3 mm, the anterior one with a well-formed embryonic shell and only fragments of the egg shell.

The lung is very long, very densely and evenly peppered with white, the specks forming longitudinal rows in some places. There is a short, triangular kidney with an extremely long anterior extension reaching to the anterior fifth of the lung. The orifice is lateral at the end, as usual, with a weak ridge running a short distance backward.

Partula (Thakombaua) lanceolata Cooke and Crampton (fig. 3, *g, h*).

Fiji: Mango Island, Lau Archipelago, no. 78942 (B. P. Bishop Mus.) E. H. Bryan, Jr.

The reproductive organs are substantially as in *P. lirata* except that the penis is longer and of about equal diameter throughout. The *vas deferens* is rather thick. The ovisperm duct is less elaborately convoluted (fig. 3, *h*).

The lung (fig. 5, *a*) is peppered with white dots. The narrow part of the kidney is nearly twice as long as the triangular portion and reaches far forward, as in *P. lirata*.

Anatomically *Thakombaua* is characterized by the small penis without a constriction, and the very short spermatheca.

Partula (Melanesica) turneri perstrigata Pilsbry (fig. 5, *c, d*).

New Hebrides: Tanna Island, no. 81632 (B. P. Bishop Mus.), E. Robertson.

The reproductive organs (fig. 5, *c, d*) are much as in *P. lirata* except that the organs are longer. The penis and its retractor are long and slender, the *vas deferens* entering at about the posterior third of the penis. The ovisperm duct is simpler and the spermathecal duct longer than in *Thakombaua*, though it does not reach medium length. The specimens opened contained neither eggs nor embryos.

The lung is opaque, grayish brown within, seen under the microscope to be minutely peppered with white specks and with a loose network of deep brown or gray pigment in fine points and short lines. There is an appearance of longitudinal striae in places. The kidney has a small triangular expansion posteriorly, about one sixth of its total length, and a very long, narrow anterior extension, the whole more than two thirds the length of the lung.

Partula turneri is type of the subgenus *Melanesica*.

Genus SAMOANA Pilsbry

Evadne Hartman, Cat. Genus *Partula*, p. 12, 1881. Not *Evadne* S. Lovén (Crustacea), 1836.

Samoana Pilsbry, Man. Conch., vol. 20, pp. 165, 263, 1909. Type *Partula canalis* Mousson.

Penis short and stout, its cavity nearly filled by a fleshy longitudinal ridge with recurved edge and adnate along one side, exactly as in *Eua*. A club-shaped epiphallus (fig. 9, *g*) surmounts the penis, the penial retractor inserted at its apex, with a slender continuation to the apex of the penis. The *vas deferens* enters the epiphallus below its apex. The spermatheca is small, oblong, on a duct of medium length. Other organs as in Partulidae generally.

The essential character of *Samoana* is that there is a well-developed epiphallus with terminal retractor muscle. In other Partulidae examined the *vas deferens* is not continued beyond the apex of the penis, but proceeds directly to the anterior or basal end, either from an apical insertion, as in *Eua*, or from a point below the apex, as in *Partula* proper; and it has no connection with the penial retractor. The spermathecal duct is somewhat longer than in *Partula*.

In the sinistral species *S. canalis* and *S. conica* the direction of recurvature of the ridge in the penis is opposite to that in the dextral species.

We have elsewhere referred to the resemblance of the epiphallus of *Samoana* to the distal section of the penis in *Partula* sensu stricto, and the probability that they may be homologous structures.

The following species belong to *Samoana*. Those marked with an asterisk have been dissected.

SAMOA

- **Samoana canalis* (Mousson), Upolu, Savaii
- Samoana canalis biconica* (Pilsbry)
- Samoana canalis semilineata* (Mousson), Tutuila
- **Samoana conica* (Gould), Tutuila
- Samoana stevensoniana* (Pilsbry), Upolu
- Samoana thurstoni* (Cooke and Crampton), Ofu
- **Samoana abbreviata* (Mousson), Tutuila

TONGA

- Samoana cramptoni* Pilsbry and Cooke, Eua

Fiji

- **Samoana alabastrina* (Pfeiffer), Moala

Samoana conica (Gould) (fig. 6, *f-h*).

Samoa: foot of Tau Peak, Tutuila, no. 84454 (B. P. Bishop Mus.), C. M. Cooke, Jr.

Specimens dissected contained neither eggs nor embryos. The penis cavity has a small longitudinal ridge in addition to the large, folded one (fig. 6, *h*). The spermathecal duct is more than half as

long as the oviduct. The vagina is longer than usual in *Partulidae*, about as long as the penis. The left ocular retractor passes over the penis (between penis and vagina) as in all sinistral *Partulidae* examined.

The lung is densely and evenly peppered with white, the particles mainly arranged in longitudinal lines. Kidney triangular posteriorly, with the narrow anterior extension nearly twice as long, the whole occupying about two thirds the length of the lung.

Samoana canalis (Mousson) (fig. 6, *d, e*).

Samoa: Safuni, Savaii, no. 75896 (B. P. Bishop Mus.), E. H. Bryan, Jr.

In the reproductive organs this species resembles *S. conica*, but it differs slightly by having the *vas deferens* more looped, and the secondary ridge within the penis is lower (fig. 6, *e*).

The lung (fig. 5, *b*) is 17 mm long, slaty black, streaked and mottled with white, the white predominating on the cardiac side. It is much shorter than the lung of *P. conica*. The kidney is 13 mm long.

In the dextral *S. abbreviata* (Mousson) the penis and *vas deferens* are as figured for *P. canalis*. The lung has no dark markings.

Samoana cramptoni Pilsbry and Cooke (fig. 6, *a-c*).

Described under Tongan species. The main difference between this and the Samoan species is that the spermathecal duct is longer.

Samoana alabastrina (Pfeiffer) (fig. 6, *i, j*).

Fiji: Moala, no. 77131 (B. P. Bishop Mus.), E. H. Bryan, Jr.

The penis and its appendages are about as in the typical Samoan species except that there is no accessory ridge in the penial cavity (fig. 6, *j*). The vagina is very short, and the spermatheca is much shorter than in other species of *Samoana* examined. The uterus contained three eggs which are nearly circular in one view, flattened in another, measuring 4.4 by 4.2 by 3.5 mm (fig. 8, *b*).

The shells from Moala correspond fully with *Partula nematoraphe* Pilsbry (Man. Conch., vol. 20, p. 279, 1909-10) said to come from "Fiji," obtained from the London dealer Geale; but this appears to be identical with *Partula alabastrina* Pfeiffer, supposed to be from the Solomon Islands; habitat was apparently incorrect.

The species has been placed in the subgenus *Melanesica*, but it proves to have all the anatomical characters of *Samoana*. A cord above the suture, such as appears in the description and figures of *P. nematoraphe*, is also to be seen in some examples of *S. canalis*.

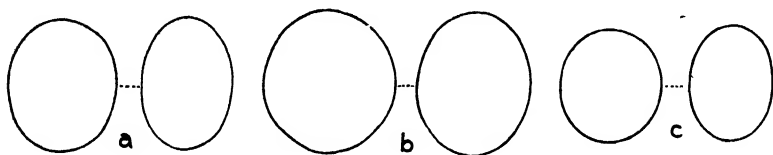


FIGURE 8.—Eggs of Partulidae: a, *Samoana cramptoni*; b, *Samoana alabastrina*; c, *Eua zebrina*.

Genus *EUA* Pilsbry and Cooke

Subgenus *NESANASSA*, new subgenus

The subgenus is named from the Greek *Νησος* (island), *ανασσα* (princess).

The oblong or obliquely conic shell is moderately to widely umbilicate, opaque, more or less variegated, of few ($4\frac{1}{2}$) whorls; peristome flatly reflected and thickened within. Soft anatomy as in *Eua*. Type, *Partula zebrina* Gould.

Eua (Nesanassa) zebrina (Gould) (fig. 3, d-f).

Samoa: wooded slope behind Pagopago, Tutuila, no. 134746 (Acad. Nat. Sci. Phila.), H. A. Pilsbry.

This has essentially the penial structure of *Eua globosa*. The *vas deferens* and the retractor muscle are terminal on the short, stout penis, the cavity of which is occupied by a fleshy ridge adnate along one side, its free edge folded over. It extends the whole length of the penis sac (fig. 3, e, f). The uterus contained two or three eggs measuring 3.35 by 3.1 by 2.65 mm (fig. 8, c). These eggs are decidedly smaller than those of the *Samoanae*. Anteriorly there may be one embryo with a shell about 4.5 mm long, without an eggshell, this apparently being absorbed before birth.

The carnivorous habit of *E. zebrina*, which apparently swallows other snails for the lime of their shells, has been described (B. P. Bishop Mus., Bull. 47, pp. 5-12, 1928).

The following species belong to this subgenus: *Eua* (*Nesanassa*) *zebrina* (Gould), Tutuila; *Eua* (*Nesanassa*) *expansa* (Pease), Upolu; *Eua* (*Nesanassa*) *montana* (Cooke and Crampton), Upolu.

Key to Genera and Subgenera

- a. Cavity of the penis with ribbed and papillose walls in the distal part, only ribbed anteriorly (fig. 9, c, d), the *vas deferens* entering some distance before the end.....Genus **Partula**
 - b. Penis with an external constriction between papillose and ribbed portions (fig. 9, b); Society Islands.....Subgenus **Partula**
 - bb. Penis not constricted (fig. 9, a).
 - c. Spermatheca and duct very short; shell with raised spiral striae, and a callous pad on the parietal wall contiguous to the columella; Fiji.....Subgenus **Thakombaua**
 - cc. Spermatheca of moderate length; no raised spirals and no callus on the parietal wall; New Hebrides.....Subgenus **Melanesica**
- aa. Cavity of the short, stout penis not papillose, occupied by a fleshy ridge with folded-over edge and adnate along one side (fig. 9, f)
 - b. A club-shaped epiphallus present, the penial retractor terminal on it, with a slender continuation to the apex of penis (fig. 9, g); shell glossy, spiral striae weak or wanting on later whorls; Samoa, Tonga, and Fiji.....Genus **Samoana**
 - bb. Penial retractor and *vas deferens* inserted at apex of penis, the *vas deferens* passing thence directly to base of penis (fig. 9, e), shell dull, with spiral sculpture.....Genus **Eua**
 - c. Shell globose-conic, with broad umbilicus, unicolored; TongaSubgenus **Eua**
 - cc. Shell oblong-conic or obliquely conic, variegated; SamoaSubgenus **Nesanassa**

This is by no means a general classification of the Partulidae, as nothing is known of the anatomy of species of the Marquesas and Micronesia, and of numerous isolated forms scattered over Polynesia; moreover, the information on Society Islands and Melanesian species is still quite inadequate.

ZOOGEOGRAPHIC RELATIONS

According to J. E. Hoffmeister (B. P. Bishop Mus., Bull. 96, p. 34, 1932), "it may be that the early history of *Eua* is related in some way to an old western Pacific continent." Harold L. Alling (B. P. Bishop Mus., Bull. 96, p. 47, 1932), who worked up the petrology of *Eua*, believes that "*Eua* and probably other Tongan islands

are the remnants of a continental series of volcanos, situated on the coast of a former continent; or perhaps I should say these islands represent a pre-Eocene continental shelf." Immediately to the east lies the Tonga Deep, a trough about six miles deep. Between the Tongan plateau and Fiji, depths seem to be 2,000 to 3,000 meters, and Samoa is separated by depths between 4,000 and 5,000 meters. It is not believed that soundings have been sufficiently thorough to determine the least depths between these archipelagos.

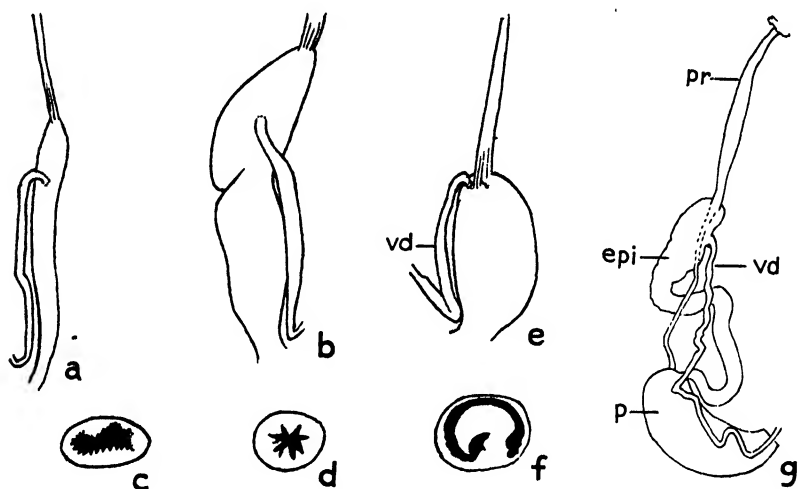


FIGURE 9.—Penes of Partulidae: a, *Melanesica*; b-d, *Partula*; e-f, *Eua*; g, *Samoana cramptoni*; Epi., epiphallus; p, penis; p.r., penis retractor; v.d., vas deferens.

This information prepared us to find the Tongan Partulidae most nearly related to the Fijian, but it turns out that they show much greater affinity to those of Samoa. Both of these island groups have only the two genera, *Eua* and *Samoana*. *Eua* has been found only in Samoa and Tonga, but one species of *Samoana* occurs on the Fijian island, Moala. Otherwise Fiji has only the very different partulid group *Thakombaua*, which is closely related to *Melanesica* of the New Hebrides.

It appears therefore that Tonga is as wholly Polynesian as Samoa in its *Partula* fauna, whereas Fiji is Melanesian but with one characteristic Samoa-Tonga genus represented by *Samoana alabastrina*.

Although the Samoan *Partulidae* are fairly well known, Tonga and the Lau Archipelago of Fiji have been so little worked that conclusions reached now are only tentative. They will have a certain value, however, if they direct attention to research in the Fiji-Tonga-Samoa region where the Melanesian and Polynesian faunas make their closest contacts.

SYSTEMATIC POSITION OF *PARTULA*

A few words on the position of *Partula* in the system of Stylommatophora may be in order. Eduard von Martens in 1860 placed the genus between *Buliminis* and *Achatinella*. This can only be regarded as a very lucky guess, as nothing was known of the anatomy of either of the Pacific genera. Fischer, 1885, knew the jaw and teeth; he ranked *Partula* as a subgenus of *Bulimulus*, which included *Amphidromus*, *Placostylus*, and others. Pilsbry, in 1900, recognized the affinity of *Partula* to Achatinellidae, Amastridae, Pupillidae, and the buliminoid snails by the possession of a kidney of the basommatophorus type and a lung without venation. It was segregated in a family *Partulidae*.

The classification adopted by Thiele (*Handbuch der Systematischen Weichtierkunde*, II, p. 658, 1931), by returning to the old idea that *Partula* is a genus of *Bulimulidae*, which he places between *Zaplagius* and *Bothriembryon*, seems distinctly reactionary. The teeth and the shape of the kidney, which he mentions as supporting that classification, are weak defenses of an untenable position. In those *Bulimulidae* having superficially similar tricuspid side teeth, the three cusps are endocone, mesocone, and ectocone. In *Partulidae* an endocone is not present, a mesocone and two ectocones being developed. The supposed similarity is one of analogy, not of homology. The triangular shape of the kidney is so common in land mollusks that it would have little value if it were alike in bulimulid and partulid snails. The resemblance claimed is merely superficial. *Bulimulidae* have a triangular kidney with the apical ureter reflected to the base of the lung, thence passing forward along the hindgut to an external opening. In *Partulidae* the kidney is dilated and triangular posteriorly, but becomes narrow and bandlike in the anterior moiety. There is no ureter, the kidney opening directly into the lung by a lateral pore at the apex of the long anterior extension and remote

from the hindgut. The texture of the veinless lung of *Partula* is so different from the copiously vascular lung of Bulimulidae that no malacologist who actually dissected a *Partula* could fail to notice their diversity. The classification of the land pulmonates in Thiele's "Handbuch" is for the most part excellent, as nearly all the groups had been well worked out by the authorities he followed; but his failure to recognize the value of the groups Orthurethra and Aulacopoda has led to occasional anachronisms, such as the inclusion of Clausiliidae in his stirps Vertiginacea, where it has no place, and his extraordinarily heterogeneous stirps Zonitacea.

A NEW HAWAIIAN ABUTILON

By

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In 1932 Mr. Otto Degener discovered in the Waianae Mountains, Oahu, an undescribed malvaceous shrub that he decided could not be referred to any known genus of the family. He described it as *Abortopetalum sandwicense*.¹ The original description of the genus *Abortopetalum* Degener reads:

Frutex; foliis petiolatis, cordatis; floribus singulis, pendentibus; calyce campanulato, 5-fissis, sine involucellis; petalis liniari-spatulatis, apparentibus aliquantum abortatis; ovario 10-cellis; stigma parva; capsula erecta, 10-cellis; seminibus reniformibus.

In this Latin text, as well as in the more complete English text, there is no character given which does not agree with *Abutilon* as interpreted by Schumann² and Baker,³ and generally accepted. The distinguishing character of the supposed new genus, namely, the narrow, spatulate, "abortive" petals, is not uncommon in species of *Abutilon*, although perhaps not so markedly developed as in this species. But even if this distinction could be made, the shape of the petals is certainly no character of generic rank in this group. Degener recognized the close relationship of *Abortopetalum* to *Abutilon*, a fact which he expressed by pointing out that the name "begins with the same two letters as does *Abutilon* and hence stands near that related genus in the Flora" ["Flora Hawaiiensis"]. No other points of relationship or distinction are mentioned.

The type locality of *Abortopetalum sandwicense* as given by Degener is "Gulch north of middle ridge between Puu Kamaohanui and Puu Pane, Oahu . . . on the eastern side of the gulch on both sides of the cattle fence." In Bernice P. Bishop Museum a specimen collected by G. W. Russ is labeled "above W. pineapple ridge, Kamanui, Waialua, at F. R. fence, E. slope, July 21, 1932." This

¹ Degener, Otto, Flora Hawaiiensis, sheet Abortopetalum and sheet Abortopetalum sandwicense, both sides, August 10, 1932.

² Schumann, Karl, Malvaceae: in Engler and Prantl, Die natürl. Pflanzenf., III, 6, p. 37, 1890.

³ Baker, E. G., Synopsis of genera and species of Malveae: Jour. Bot., vol. 31, p. 71, 1893.

locality is close to that from which the type was obtained and may be the identical locality.

The plant collected by G. W. Russ agrees with the description and illustration given by Degener except for the slightly less pronounced dentation of the leaf blades, and in other minor details of size, the slightly shorter calyx and petals (only one specimen measured), young staminal column, and filaments. They agree perfectly in the shape and size of the leaves, pubescence, and in the shape and color of the flowering parts as far as it can be judged from dry material. In studying this specimen I have found no characters additional to those given by Degener which serve to distinguish it from *Abutilon*. This specimen, as well as the one described by Degener, agrees with *Abutilon* in the absence of bracteoles, in the form and arrangement of stamens and styles, and in the persistently connate, distinctly one-celled, bivalvate, several-seeded carpels; the seeds are arranged in one series.

For these reasons I do not agree with Degener that a new genus is represented. In no characters of generic rank do the plants differ from *Abutilon*, to which genus they should therefore be referred.

Abutilon sandwicense (Degener) Christophersen, new combination.

Abortopetalum sandwicense Degener: Flora Hawaiiensis, August 10, 1932, both sides of the sheet.

During a systematic survey of the valleys of central Lualualei below Kanehoa, Oahu, in company with Mr. d'Alté A. Welch, I found a closely related form of this species flowering and fruiting on June 29, shortly after Degener's discovery. The shrubs have an ascending habit, reaching a height of about 4 meters. They were found growing in a small clump at an elevation of about 1,500 feet in the open, upper part of the forest on the northern slopes of one of the valleys between Puu Kani and Puu Kaua. The valley was designated by us as no. 9, the ninth valley counting from the south. Near by, in the shade of the forest, another small clump of shrubs was found ascending to a height of about 10 meters, the stems being intertangled in the manner of *Hibiscus tiliaceus*. Still another shrub, about 2.5 meters in height, was found in the open on the flat ridge between this valley and the next valley to the south. Three weeks later, another clump of this same form was found at an altitude of about 1,800 feet in open forest at the head of a valley, no. 17, farther

north, almost directly below Puu Kanehoa. The shrubs were in flower and fruit and attained a height of 2 to 3 meters.

These shrubs differ in minor details only, and all (with possibly one exception) are to be referred to the same form. This form is so closely related to *Abutilon sandwicense* that I consider it merely a variety of this species.

Abutilon sandwicense (Degener) Christophersen variety **Welchii**, new variety (fig. 1).

A typo differt laminis foliorum oblongioribus longe acuminatis, calicibus angustioribus, petalis brevioribus, parte horum superiore lata rubro-brunnea, columna staminea brevior, parte horum superiore rubro-purpurea, carpellis numero 8-10, saepe 9, interdum longioribus.

This variety, named in honor of my friend and inspiring field companion d'Alté A. Welch, Assistant Malacologist at Bernice P. Bishop Museum, differs from the type of the species in its more oblong leaf blades with long acuminate tips, its narrower calyx, shorter petals, the upper broad part of which is reddish brown, its shorter staminal column with reddish-purple upper part, and its varying number of carpels (8-10) which may attain a greater length.

The ascending shrubs are 2-4 m high. Branches terete, densely whitish or yellowish tomentose, the older ones glabrous. Leaves alternate, petiolate, leaf blades 8-17 cm long and 5-11.5 cm broad, ovate, cordate, acuminate, with irregularly dentate or crenate-dentate margin, upper surface slightly rough, sparsely stellately pubescent to glabrate with veins prominent in the lower part, lower surface slightly paler, velvety stellately tomentose with prominent veins, petioles stout, as a rule arcuate, terete, densely tomentose, 5-12 cm long. Flowers solitary in the axils of the upper leaves, pendent, pedicels stout, terete, articulate, densely tomentose, 2-4.5 cm long, fruiting pedicels erect, stouter, grooved above the articulation, to 9 cm long and 2 mm thick. Bracteoles none. Calyx (in fresh material) campanulate, 3-4.3 cm long and 1.6-2.3 cm broad, divided to about the middle, pale yellowish green, outside stellately pubescent, inside and margin of lobes albo-pilose, lobes 5, 3-veined, lanceolate, acute or acuminate, 9-12 mm broad at base. Corolla (in fresh material) campanulate, narrow, or broadly open. Petals 5, free, opposite the lobes of the calyx, attached at the base of the staminal column, spatulate, acute or bluntly acuminate, glabrous except for the ciliate basal margin, the lower part broadly linear, slightly broader at the base, greenish yellow, the upper broadened part reddish brown (Hessian brown—Ridgway) with distinct greenish-yellow veins and irregularly serrulate margin, in fresh material 4-4.3 cm long, to 1.4 cm broad in the upper part, and 3-4 mm broad at base. Staminal column fluted, tapering, albo-pilose, more densely so at the base, in fresh material greenish yellow except for the reddish-purple uppermost part, 3-3.5 cm long including the stamens. Stamens numerous in a head at the top of the staminal column, filaments reddish purple, about 5 mm long, anthers reniform, one-celled, when ripe with reflected valves. Styles 8-10, glabrous, upper free part about 1 cm long, apex stigmatose. Ovary ovoid, tomentose, 8-10-celled (commonly 9-celled). Mature carpels surrounded by persistent calyx, connate at base, stellately pilose on the back and at the apex, acuminate, bivalvate, 20-25 mm long and up to 6 mm broad and thick, the entire capsule being about 20 mm broad. Inter-

carpellary ribs branching between the carpels, becoming detached at maturity. Dorsal ribs partly detached at maturity. Seeds 3-5 in each carpel, narrowly reniform, flattened, brown, with stiff erect stellate white hairs, 3 mm long, 2 mm broad, and 1-1.5 mm thick.

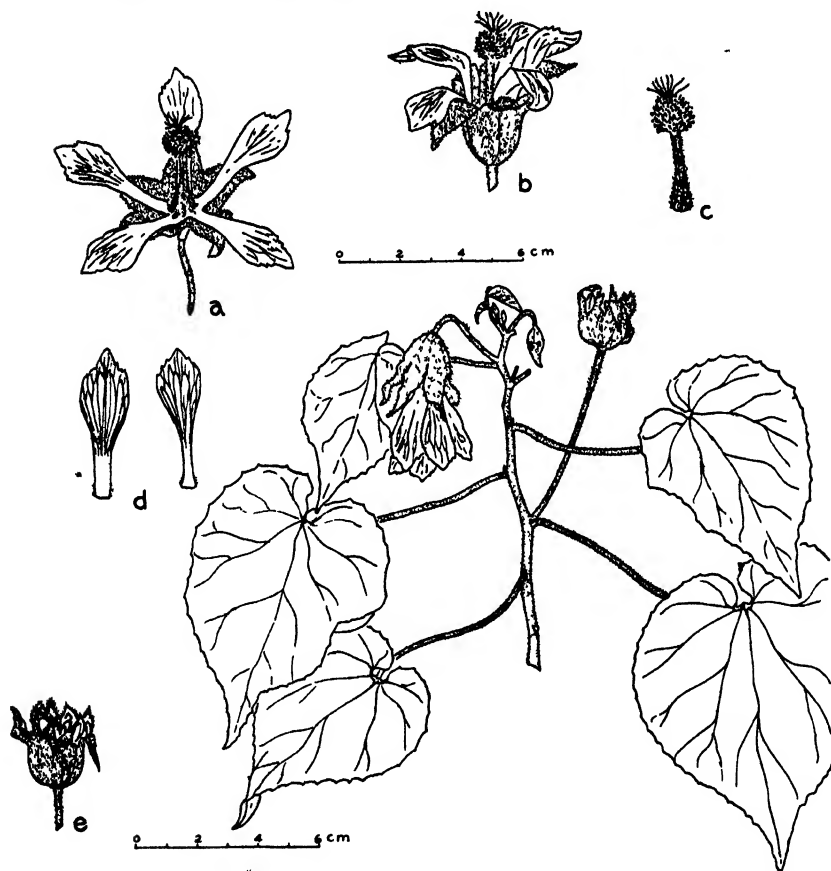


FIGURE 1.—*Abutilon sandwicense* variety *Welchii*: a, b, flowers; c, pistil and stamens; d, petals; e, calyx and capsule.

Oahu, Luakalei valley, central part below Puu Kanehoa, altitude about 1,500 feet, flowers, fruit, June 29, 1932, Erling Christophersen nos. 3712, 3720, and 3714 (type, in Bernice P. Bishop Museum); Luakalei valley, central part below Puu Kanehoa, altitude 1,800 feet, flowers, fruit, July 20, 1932, Erling Christophersen nos. 3721 and 3724 (?).

The description of this variety is based exclusively on the specimens in the type collection. The other specimens cited differ somewhat in details: in no. 3712 the carpels have more elongated, almost awl-shaped tips, the petals are reddish brown only in the very uppermost part, and the shrubs are as much as 10 meters high. In nos. 3720 and 3721 the dentation of the leaves is more pronounced. In no. 3724 the leaves are less elongated, distinctly and sharply dentate, and the carpels are only 15 to 20 mm long with blunt, short tips. The plants of this number may possibly belong to a distinct form.

Abutilon sandwicense is obviously related to *A. eremitopetalum* Caum⁴ (*A. cryptopetalum* Caum), from which it differs, among other characters, in its exerted petals, the strongly reduced petals of *A. eremitopetalum* being enclosed by the calyx. From *A. Menziesii* Seemann it differs, among other characters, in its larger size of all parts and its linear-spatulate petals. It is worthy of note that Australia harbors species of *Abutilon* with a more or less pronounced reduction of the petals.

I want to express my indebtedness to Professor Dr. R. E. Fries, who has read this paper in manuscript.

⁴ *Abutilon cryptopetalum* Caum being a homonym, the name having been preoccupied by an Australian species, I take the opportunity of proposing here, with the kind permission of Dr. Christophersen, a new name for the species, which will still be descriptive of its most conspicuous character, thus:

***Abutilon eremitopetalum* Caum, new name.**

Abutilon cryptopetalum Caum: in Degener, *Flora Hawaiiensis*, June 14, 1933.

—Edward L. Caum.

DIELLIA AND ITS VARIATIONS

By

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DIELLIA AND ITS VARIATIONS

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Christ (5, p. 241)¹ remarks in describing Hawaiian ferns:

The most striking genus in the Hawaiian flora is *Diellia*, very neatly quadripinnate, tufted ferns with stems gleaming like copper and kindred to those of *Lindsaya*, from which on the whole a habitual difference, rather than a difference founded really on the somewhat inserted sorus, separates them. With almost volcanic violence a type is here torn asunder into at least seven species, of which the simplest, *Diellia pumila*, delusively resembles our *Asplenium trichomanes*, and the most developed, *Diellia centifolia*, resembles a tripinnate *Odontosoria*.

Brackenridge, Hillebrand, and Diels have striven to fix this group exactly. Here aesthetics seem to have been the guiding motive in the determination. But perhaps "have been" is not the right expression for a group that appears to the searcher to be still in confusion. They alone are worth a trip to that "Paradise of the Pacific."

In this statement Christ could not have meant *Diellia centifolia* (pl. 1, *A*), for this is once-pinnate, as illustrated by Diels and described by Hillebrand. It was probably *D. Knudsenii* variety or *D. Mannii* (pl. 2, *A*).

In a survey of the genus, preparatory to a morphological study of the young sporophyte, I faced so many uncertainties in nomenclature among collectors, so many variations in form in herbarium material, so many evidences of the fact that the genus is rapidly disappearing, that it seemed worth while to record what facts I could obtain from fresh material and from herbaria in Hawaii and elsewhere. (See Table 1.)

Hooker and Hillebrand include these species under *Lindsaya*, but Diels, Christ, Christensen, Bower, and Copeland place them in a separate genus, *Diellia*. Bower (2, pp. 26-28) gives from Diels and Christ these diagnostic features for maintaining it as a substantive genus: the leaf segments are not unilateral but obliquely triangular, and the indusium of *Diellia* is broadly adherent. Christensen (6, p. 25) says:

"
Its systematic position is not settled. . . . I believe that only two or three really good species can be upheld. The eighth spe-

¹ Numbers in parentheses refer to Literature Cited, p. 15.

Table 1. Specimens of *Diellia* in Herbaria.

EXAMINED IN HERBARIA	DIELLIA MANNII	DIELLIA ALEXANDRI AND VARIETIES	DIELLIA KNUDSENII AND VARIETIES	DIELLIA LACINIATA AND VARIETIES	DIELLIA CENTIFOLIA	DIELLIA FALCATA PUMILA
Bernice P. Bishop Museum.....	2	7	...	...	...	34
Brooklyn Botanical Garden.....	4	4	...	...	...	3
University of California.....	3-4	3-4	1	...	...	14
E. B. Copeland.....	...	...	...	...	...	6
Massachusetts State College.....	...	...	...	...	...	1
Missouri Botanic Garden.....	...	...	...	...	...	10
New York Botanical Garden.....	6 ^b	7	2	3 ^c	1	13
Sheffield Scientific School.....	4	3-4 ^d	1 ^e	...	1 ^f	8
Smith College.....	...	4	...	...	...	3
F. G. Smith.....	...	...	...	...	...	29
E. LeRoy Topping.....	...	...	...	...	...	7
United States National Museum.....	1	1	1	...	...	13-15
Wellesley College.....	1	1	...	...	...	5
TOTAL.....						146-148
KNOWN FROM LISTS						
Amherst College.....	1	1	...	...	...	...
University of Berlin.....	...	7	6	3	...	...
Herbarium Bonaparte, Paris.....	...	6	...	...	...	...
Gray Herbarium.....	1	...	...	...	4	5
Kew Gardens.....	2	...	...	...	1	8
Vassar College.....	...	1	...	...	5 ^g	1
University of Vermont.....	...	2	...	...	...	...
TOTAL.....	25-26	47-49	11	6	2	22
						9

^a One is likened to *Diellia Boydii*; ^b six fragments, bits of pinnae; ^c one is called *D. Boydii*; ^d one may be *D. Knudsenii* or *D. Mannii*; ^e called *D. Knudsenii*, but answers to *D. centifolia*—one may be *D. Alexandri* or *D. Knudsenii*; ^f called *D. Knudsenii*, pictured by Diels, but not included in his list of species in the Berlin herbarium.

cies, . . . *D. Mannii*, is totally different from the other seven species and I place it in the genus *Loxoscaphe*," Copeland (7, p. 74), on the contrary, says: "The genus seems to me to be a natural one and to include that species [*D. Mannii*], and to be related in its entirety to *Asplenium*."

This group of ferns, whether a distinct genus or not, has been considered endemic in Hawaii since the discovery of the species *Diellia erecta*, *D. falcata*, and *D. pumila* by Brackenridge on the Wilkes Expedition (1838 to 1842). Species and varieties found later, mostly the result of Knudsen's collecting on Kauai, were recorded by Hillebrand (9) and the types deposited in the Museum of Berlin and illustrated by Diels (9).

An examination of the records of various herbaria shows few dates later than the one for the first collection of any species except *Diellia falcata*, *D. erecta*, and *D. pumila*. Specimens from Kauai bear the dates: *D. Knudsenii*, Knudsen, 1883; *D. centifolia*, 1879; *D. laciniata*, 1879?; *D. Mannii* (*Loxoscaphe*), 1879. *D. Alexandri* appears mostly in early collections (about 1879) from Maui; the exceptions are a specimen from Maui collected by Baldwin in 1892 and one from Molokai collected by Forbes in 1912.

In the winter and spring of 1928 and 1929 I collected ferns on the islands of Kauai, Oahu, Maui, and Hawaii. On Kauai in the region of Halemanu, where Knudsen recorded the finding of *Diellia laciniata*, *D. centifolia*, *D. Alexandri*, and *D. Knudsenii*, I found not a single plant of these species. From the reports by others of the same lack of success, I am inclined to think that these species have almost, if not quite, disappeared from Hawaii. At any rate, the specimens are too few and too fragmentary to draw conclusions regarding characteristics which are supposed to determine the species. Many specimens in herbaria are represented by only a bit of a frond. It is possible to speak with more assurance concerning *D. Alexandri* (pl. 3). I have seen 25 plants of this species and find enough differences in the amount of dissection of the fronds to explain all the varieties mentioned by Hillebrand.

Brown (4, pp. 46-47) describes a new species, *Diellia Brownii*, from the Marquesas, the first found outside Hawaii. It has anastomosing veins but is much larger than any other species, and the shorter sorus, in proportion to its width, reminds me of some of the

Aspleniums. Christensen makes the following comments on a specimen of *D. Brounii* examined by him in 1932:

This is not a species of *Diellia* but very closely related to *Nephrolepis* (*Isoloma*) *acutifolia* (Desv.) Christ. It may [be] considered a variety of it or, if you like, a species, differing by the not confluent sori. The genus *Isoloma* Thn. (if available name) should probably be restored.

Diellia falcata, *D. erecta*, and *D. pumila* are well represented and appear in the herbaria of the United States and are still collected. Besides those listed in Table 1, I have examined 11 plants collected by Mr. LeRoy Topping on the mountains of Oahu (Kawaihapai), 6 from a different region on Oahu (Makaleha), and 12 plants and 8 extra fronds from the island of Lanai collected by Mr. G. C. Munro. In addition, I have a few fronds from Maui and one plant from Molokai, a gift from Mr. Otto Degener. In all, some 130 plants and extra fronds were available for study of variation.

Brackenridge (3) describes and figures *Diellia falcata* and *D. erecta* (pl. 1, B) and describes *D. pumila* (pl. 2, B). His type specimens, deposited in the United States National Herbarium, are from Puu Kaala (Oahu), western Maui, and Oahu, respectively. Since that time these species have been found on the other large islands of Hawaii, but several collectors call them "rare." Hillebrand (9, p. 621) remarks: "The distinctive characters of the three preceding species [*D. falcata*, *erecta*, and *pumila*] mark extreme forms which gradually approach each other." Bailey (1, p. 23) states:

It seems marvellous that ferns so nearly alike as the last three species [*D. falcata*, *erecta*, and *pumila*], all of whose habits are much the same, and whose forms are very erratic, should be separated, while others of constant forms, but differing in habit as well as form, under the circumstances must be united.

Christensen (6, p. 25) thinks that of the whole genus "only two or three really good species can be upheld"; but he does not say which these may be. Descriptions of the three species (*D. erecta*, *falcata*, and *pumila*) as given by Brackenridge, Diels, and Bailey differ in a number of points. The length of the stipe as recorded by these four taxonomists is for *D. falcata* 1 to 4 inches (2.5 to 10.2 cm), which is 4 inches less than the shortest length given for *D. erecta*, 5 to 10 inches (12.7 to 25.4 cm). The stipe of *D. pumila* is shorter yet, 1 to 3 inches (2.5 to 7.6 cm). All of them emphasize the paleaceous stipe of *D. falcata* (pls. 1, B; 4, A). As described

by Brackenridge (3, pl. 219), the stipe is "terete, of a dull brown color, and densely chaffy with ligulate, membranaceous, entire, reticulated paleae" (fig. 1, *f*). Hillebrand (9, p. 620) says these paleae become narrower and acuminate toward the rachis, "which generally carries reddish fibrils" (fig. 1, *e*). Brackenridge writes that *D. erecta* has "reddish-brown," "nearly round" stipes with "a few stiff scales at the base," and that *D. pumila* is "naked." Hillebrand says that *D. pumila* has a few stiff dark scales at the base of the stipes.

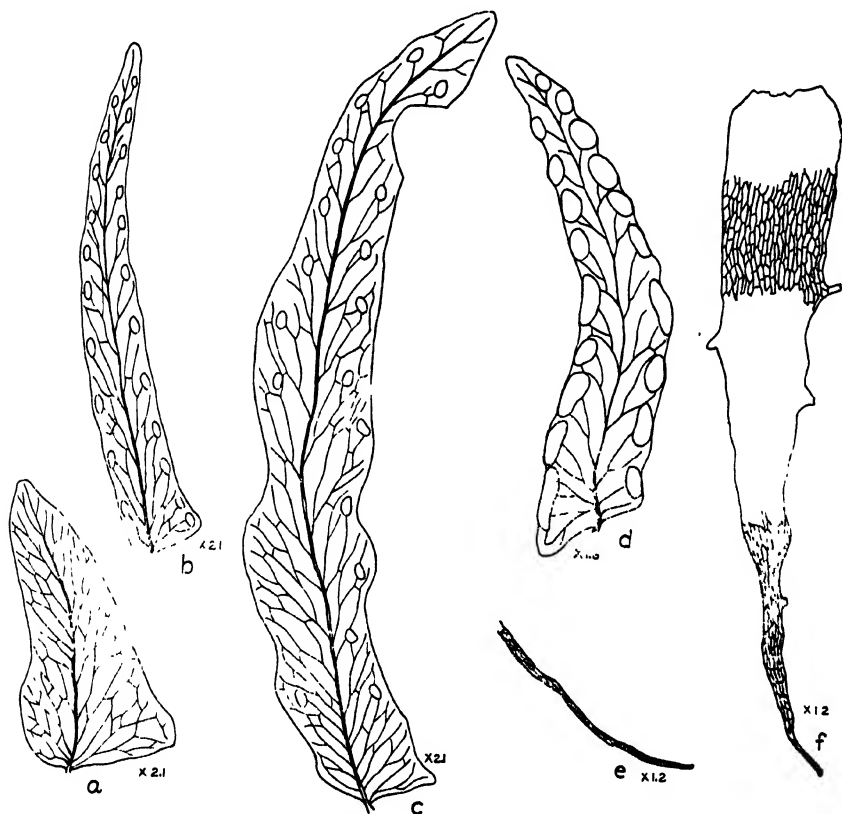


FIGURE 1.—*Diellia*: *a-c*, pinnae from a plant collected in Makaleha, Oahu, showing variation in size, venation, and position of sori, auricles less pronounced than usual; *d*, typical pinna from a plant collected by G. C. Munro on Lanai, fusion of sori less than usual; *e*, fibril from one of the stipes on a specimen of *D. falcata* in Missouri Botanical Garden (compare with palea in fig. 1, *f*); *f*, palea from a plant collected in Makaleha, Oahu, February 1, 1931, probably *D. falcata*, center of palea composed of cells like base and tip.

The length of the frond differs in the species also. *D. falcata* is 12 to 18 inches (30.5 to 45.6 cm), *D. erecta* 7½ to 15 inches (19 to 38 cm), and *D. pumila* is 3 to 9 inches (7.6 to 22.8 cm). Brackenridge gives 3 inches (7.6 cm) as the length of the whole frond plus the stipe for *D. pumila*. I am unable to decide whether or not the length of the frond as given is exclusive of the stipe in all the descriptions.

The fronds are lanceolate in *D. falcata* and *D. erecta*, linear in *D. pumila*. Brackenridge gives the length and width of the pinnae in *D. erecta* as 2 inches by 3 lines (5.1 by 0.6 cm), Bailey as 1 inch by 3 to 4½ lines (2.5 by 0.6 to 0.8 cm). Hillebrand gives for *D. falcata* 1 to 3 inches by 2 to 6 lines (2.5 to 7.6 cm by 0.4 to 1.2 cm). Brackenridge pictures the pinnae of *D. falcata* as once and a half as long as those of *D. erecta*. *D. pumila* is consistently smaller, 3 to 8 lines by 1½ to 3 lines (0.6 to 1.6 cm by 0.3 to 0.6 cm). As suggested by their dimensions, the pinnae are more or less linear in *D. erecta* and *D. falcata*; in *D. pumila* ovate to triangular. All three have distinct auricles on the superior half and this part twice as broad as the inferior half. In addition, *D. falcata* is said to be falcate in shape, as the name implies, or ensiform. *D. erecta* has one or two pairs of lower pinnae about an inch apart, ovate rather than linear; *D. falcata*, according to Brackenridge, shows the pinnae approximate. In *D. pumila* the pinnae are crowded and at the base are orbicular. All authors describe the sori in *D. erecta* as intramarginal, but in *D. falcata* and *D. pumila* as marginal to submarginal, except *D. falcata* β variety, of Hillebrand, which is marginal. Brackenridge describes the tip of the frond of *D. falcata* as "short and hastate," and Hillebrand calls attention to the apex, "pinatifid . . . with cultrate to cuneate segments." These features are not mentioned by either writer for *D. erecta* or *D. pumila*.

As to habits of growth, Brackenridge remarks: *D. erecta* has a "tufted" appearance and is found "in mountain forests of the western division of Maui"; *D. falcata* "on open and dry rocky ridges; rare. Rootstock short and globular. . . . Fronds few, tufted;" *D. pumila* in "crevices of the rocks; rare. . . . Caespitose." Bailey finds *D. pumila* "on the damp side of gulches." Applying the characteristics mentioned by Brackenridge, Hillebrand, Diels, and Bailey to the specimens of the three species which could be examined, *D. pumila* is the most easily recognized. It is a good species, according

to Brackenridge. The same can not be said of *D. falcata* and *D. erecta*. If, as Brackenridge suggests, the length and the paleaceous character of the stipe and the marginal or submarginal sori are the determining points, the length of the stipe and position of the sori are variable, even in the specimens most clearly like the type. If the paleaceous character be insisted upon, only about 15 specimens could be placed here (pl. 4, *A*). Removing from the group these 15 specimens of *D. falcata*, 11 which are quite surely *D. pumila* (3 or 4 others that may be *D. pumila* are too imperfect for identification) and 4 or 5 *D. erecta* (pl. 1, *B*), there are left about 100, which intergrade: they have the general appearance of *D. falcata*, but few or no scales, and a short stipe and the position of the sorus like *D. falcata*. Others resemble *D. erecta* but have too short a stipe and the sori marginal.

Dr. F. O. Bower suggested to me that possibly a study of the plants from the different islands might throw some light upon their variations; that from the separation of their habitats upon the mountain slopes there might come some special evolutionary peculiarities. It seemed possible to make a comparison of plants from Oahu, Molokai, and Lanai. From Oahu I studied one set of 11 plants, gathered at one time from the same place, Kawaihapai; a second set of 5 from Makaleha; and a single plant from Pohakea. Besides these I examined in the herbaria of other institutions a few more specimens whose locality was indicated clearly on the sheets. In this first set, collected January 27, 1929 (pl. 4, *B*), there is much variation in the length of the fronds, stipes, and pinnae; the fronds range from 5 to 13½ inches (12.7 to 33.5 cm) (*erecta*),² the stipes from 2¼ to 5 inches (5.7 to 12.7 cm) (*falcata*). This is more nearly the length of *D. falcata*, as most of the stipes are much less than 5 inches (12.7 cm) long. The pinnae were measured for width close to the point where they narrow beyond the auricle. The longest pinna is 2⅝ by 5/16 inches (6.7 to 1.1 cm), the shortest 1¼ by ⅜ inches (2.8 by 0.9 cm). The width is much greater, twice as much in some pinnae, but the length is slightly more than that given for the longest pinna of *D. erecta*, but much too short for *D. falcata*. The number of pinnae is less than that recognized for *D. falcata*, as Brackenridge (3, pl. 31) illustrates 37 for *D. falcata* and 28 to 30 for *D. erecta*.

² The use of *erecta* and *falcata* in parentheses indicates that the feature mentioned suggests one or the other species.

Most of the stipes are smooth, but a few show some slender fibrils (*erecta*). In some fronds, especially young ones, the sori have a distinctly intramarginal position; in others they project even beyond the margin (*erecta*, *falcata*). All agree in having lanceolate fronds, falcate pinnae, a difference in the two halves of the pinnae, and an auricle distinct but not always sharply so (fig. 1, *a-c*).

Besides the differences in the fronds of different plants, as great differences appear in the fronds on the same plant; differences in position of sori, of stipe length, and pinna shape (pl. 4, *B*; fig. 1, *a-c*). Brackenridge (3) defines the species: *Diellia falcata* "differs from the preceding species [*D. erecta*] in its shorter and paleaceous stipe; in the falcate fronds tapering at the base; and in having the indusium about equal with the margin." As a description of the plants studied, this sentence does not indicate a clearly defined species, though it applies better to *D. erecta* than to *D. falcata*.

Dr. W. R. Maxon has told me that there are in the United States National Herbarium 10 to 12 specimens of *Diellia* differing from *D. falcata* and *D. erecta*, but resembling them more than any other species, so that he had thought of making a new species. I can not see how the making of a new species would help to solve the problem presented by the plants which I have studied, for in many specimens two fronds on the same plant differ as widely as fronds on two plants.

The second set, from Makaleha, Oahu, collected by Mr. Topping, consists of smaller plants than the type, and several fronds of the youngest have scaly stipes with the lowest pinnae more deltoid and farther apart. The longest frond measures $9\frac{1}{2}$ inches (24 cm) and its stipe $2\frac{1}{2}$ inches (6.4 cm). The sori are marginal, but some of the fronds are evidently too young for sori. A study of this set alone might lead to the conclusion that scales are a juvenile characteristic, but in other specimens some old fronds have scales and some young ones are without them. In herbarium specimens from other places the following characteristics are noticed:

Makaleha: 2 or 3 plants, rather small, with fibrils only, stipes $1\frac{1}{2}$ to $2\frac{1}{2}$ inches (3.8 to 6.4 cm) (*falcata*), fronds 9 inches (22.8 cm) (*falcata*), intramarginal sori (*erecta*) to those projecting (*falcata*).

Mokuleia: 2 plants, all scaly stipes, 2 to $2\frac{1}{4}$ inches (5.1 to 5.7 cm) (*falcata*), fronds 15 inches (38.2 cm), pinnae $1\frac{3}{4}$ by $\frac{3}{4}$ inches (4.4 by 0.6 cm), sori submarginal to marginal with coenosori (*falcata*).

Waiaepae: 2 sheets, all fronds scaly, stipes 4 to 6 inches (10.1 to 15.2 cm)

(*erecta*), fronds 15 to 17 inches (38.2 to 43.2 cm), sori marginal (*falcata*), pinnae $2\frac{1}{2}$ by $5/16$ inches (6.3 by 0.8 cm) with coenosori occasionally.

The specimens from Makaleha, Mokuleia, and Waianae show even wider range of variation than those from other parts of Oahu, for there is some fusion of sori, and two sets are paleaceous.

From Molokai Bernice P. Bishop Museum has 11 specimens of *Diellia*, 7 of them collected by C. N. Forbes at Pukoo, 2 from Pelekunu Valley (pl. 5, *B*); 2 from Kaunakakai; 3 in the Missouri Botanical Garden, 2 from Pukoo; and 2 from Kahuaai Gulch collected by Mr. Otto Degener, one presented to the University of California and the other to me. A study of 16 of these plants showed the following features, listed, measured, and tabulated as before: length of stipes $1\frac{1}{2}$ to 7 inches (3.8 to 17.2 cm) (*erecta*), of fronds $3\frac{1}{2}$ to 24 inches (8.8 to 60.71 cm), with the longest stipes belonging to the longest fronds, 18, $18\frac{1}{2}$, and 24 inches (45.6, 46.9, and 60.7 cm). Another group might be selected, with stipes ranging in length from 3 to $4\frac{1}{2}$ inches (7.6 to 11.4 cm) and fronds from 7 to 13 inches (17.2 to 32.9 cm)—the shortest group with stipes $1\frac{1}{2}$ to 3 inches (3.8 to 7.6 cm) belong to fronds from $3\frac{1}{2}$ to 12 inches (8.8 to 30.4 cm), most of them less than 12 inches.

None of the 16 plants are paleaceous, a few have marginal sori, and the number of pinnae ranges from 16 to 42, according to the size of the plant. Most of these features indicate *D. erecta*, though some of the specimens are labeled *D. falcata*. But there is some disagreement, for though most of them have intramarginal sori, a few have marginal. The largest fronds have 37 pairs of pinnae, more than those of *D. erecta* or even *D. falcata*.

From Lanai Bernice P. Bishop Museum has two sheets of *Diellia*, not identified, with 6 fronds badly broken. They were collected by C. N. Forbes in 1917. The stipes are not paleaceous and are about $2\frac{1}{2}$ inches (6.3 cm) long for an 11-inch (27.9 cm) frond. The fronds have very large sori, which in the dried condition almost touch across the frond. A third sheet, of unidentified plants, collected by Mr. G. C. Munro in Mahana Valley in a sea-water hole (pl. 6, *A*), shows 2 fronds, 12 and $15\frac{1}{2}$ inches (30.5 and 39 cm) with stipes $2\frac{3}{4}$ and 3 inches (7 and 7.6 cm) long. They have 39 pairs of pinnae with large sori, confluent but not really marginal (fig. 2). The sori are so full that they touch across the vein. In a single sorus I

counted more than 200 sporangia. The frond resembles *D. falcata*, except for the lack of 'paleae. The amount of confluence of the sori is greater than in any other specimen, in some pinnae extending half their length and in many being most extended near the auricle.

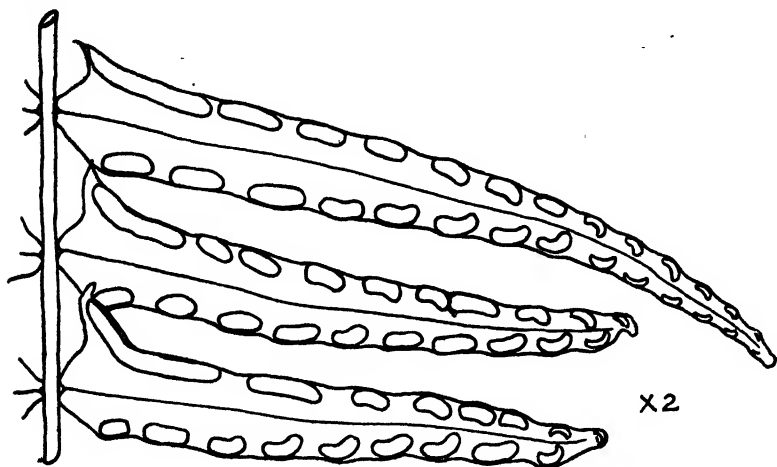


FIGURE 2.—Portion of central part of longer frond of *Diellia* illustrated on plate 6, A, showing coenosori.

A collection from Mahana Valley, July, 1929, sent me by Mr. Munro, consists of 12 plants and 8 separate fronds taken from different plants which had been left among the rocks. Munro's description of the habitat is as follows:

Elevation 1960 feet, growing on a very steep valley side, on faces of rock, not decomposed sufficiently to be actively eroding but soft enough and with interstices enough to hold moisture, also in crevices of harder rock. Suffering at present from unusually dry conditions. Shade is fairly dense from the tops of large *Pisonia* and *Aleurites* trees but not dense enough to interfere with fern growth. This plant, however, seems to be confined to rock faces where it has least competition.

In the plants from Lanai (pl. 7), the stipes are grooved as usual. They measure 2 to 4½ inches (5.5 to 11.4 cm) in length; have at the base 5 or 6 very long scales or fibrils, which are more slender than in *D. falcata* (fig. 1, f). The pinnae are obtuse, 1¾ by ¼ inches (4.5 by 0.6 cm) long in the longest frond, which is 16 inches (40.5 cm) and the stipe 3 inches (7.6 cm) long. This is short for a typical *D. erecta*. The other loose fronds vary also in the width of

the pinnae; their shape is more like that of some *D. pumila*, especially in the younger and more delicate fronds where the sori are fewer. Sori of large size and confluent seem to be common (fig. 1, *d*).

From Maui, Kauai, and Hawaii I have seen only a few plants, not enough to compare as a set with those of the other islands (pl. 5, *A*).

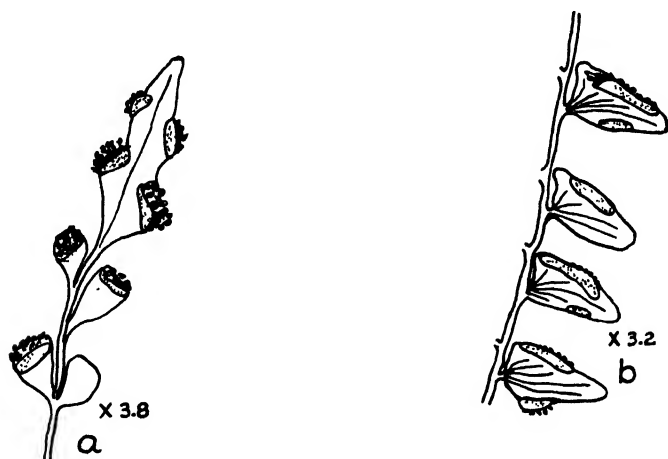


FIGURE 3.—Portions of *Diellia pumila* (?) illustrated in plate 6, *B*: *a*, tip of smallest frond, where sori are carried to tip in process of reduction of pinnae; *b*, a few pinnae near middle of largest frond—note size of sori, probable fusion, and small amount of anastomosing in veins.

A small plant recently sent me from Pohakea Pass, Oahu, is so much like *Asplenium Trichomanes* in its general appearance that H. Christ might have had it in his hands when he likened it to *Diellia pumila*. But while just one frond is like *Asplenium Trichomanes*, the others are more like *A. platyneuron*, with the pointed pinnae, auricles, and sori of *Diellia* (pl. 6, *B*). The species must be *D. pumila*, but the sori are fewer and nearer together (fig. 3, *b*). The veins anastomose less, perhaps because the pinnae are so small; but a more unusual feature is the distinct fusion of sori (fig. 3, *a, b*), so that in a few pinnae there is a suggestion of *Lindsaya*. In different herbaria I have seen 3 or 4 specimens that exhibit these features. Obviously variation is not entirely lacking in *Diellia pumila*, which is the most constant species. In the fusion of the many sori the line extends to the blunt tip of the pinna (fig. 3, *a*).

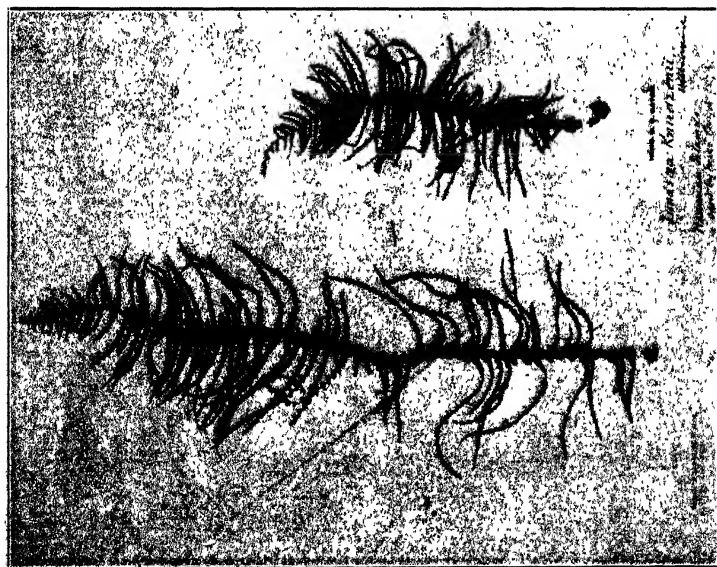
In a study of species, plants should be compared in the field to note such special adaptations to the environment as lengthened stipe in shady situations, thinner fronds, and different size in different situations where the moisture content of the soil might affect the whole growth. Even the scaliness of the frond and stipe should be examined as to variations appearing in the different conditions of the habitat. I believe that variations may be definitely caused by ecological conditions and that on the different islands variations may be developing along certain lines which are related to ecological conditions. Besides this possibility of ecological species it should be remembered that Hawaiian plants, even aside from habitat causes, are noted for their great variation in every way. Such studies as this can be only suggestive, but unless botanists are very fortunate there will be even less material in the future than I have had for experimental work. For many plants I have not tried to determine the species, as I am more than ever inclined to the view of Hillebrand concerning the three species, *Diellia erecta*, *D. falcata*, and *D. pumila*: "Distinctive characters . . . mark extreme forms which gradually approach each other." That certain plants are clearly the ends of a series in which the middle members are much more numerous and less well defined is indicated by this comparison of *Diellia*.

I appreciate that conclusions drawn from such meager material may have little value, but lest there should not be an opportunity in the future for a study of a genus which is endemic in Hawaii and so rare that only a few plants have found their way into herbaria during the last 20 to 30 years, the few facts recorded here and the variations especially noted may not be without help for further study by a fortunate collector and investigator.

This study was begun in Hawaii during the winter and spring of 1929, when I was enjoying a Bishop Museum Fellowship from Yale University. To Mr. LeRoy Topping of Honolulu and to Mr. G. C. Munro of Lanai my thanks are due for collections of *Diellia*; to Mr. E. H. Bryan, Jr., and to Miss Marie C. Neal for willing companionship on collecting trips; and to Dr. H. E. Gregory and the Trustees of Bernice P. Bishop Museum for a room and facilities in the Museum buildings.

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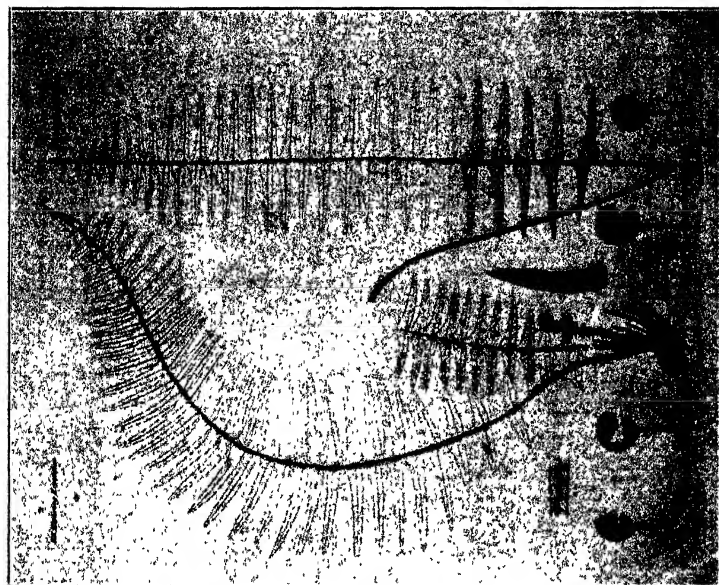
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A

PLATE 1.—*Dielliae*: A, *Lindsaya Knudsenii* Hillebrand (so labeled) (features of *Lindsaya centifolia* Hillebrand as illustrated by Diels and described by Hillebrand), length of frond without stipe 13 inches, stipe 7 inches (Sheffield Scientific School); B, *Diellia falcata* Brackenridge (left), length of frond without stipe 16 inches, stipe 2-3 inches, and *Diellia* (right), Brackenridge (right), length of frond without stipe 12-15 inches, stipe 6-10 inches. (Reproduced from Brackenridge.)

B



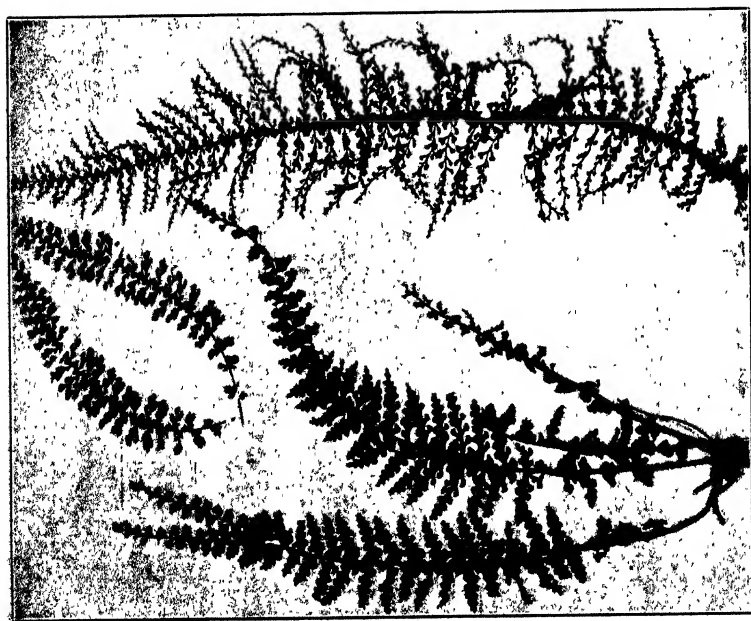


B



A

PLATE 2.—*Dielliae*: A, *Diellia Mannii* (Eaton) Robinson, Kauai, collected by Hillebrand and Lydgate, length of frond without stipe $16\frac{1}{4}$ inches, stipe $4\frac{3}{4}$ inches (B. P. Bishop Museum) ; B, *Diellia pumila* Brackenridge (lower right-hand corner) and *D. erecta* Brackenridge, length of longer frond of *D. pumila* without stipe $3\frac{3}{4}$ inches, stipe three quarters of an inch, length of frond of *D. erecta* (second frond from right) without stipe $8\frac{3}{4}$ inches, stipe $1\frac{1}{4}$ inches (B. P. Bishop Museum).

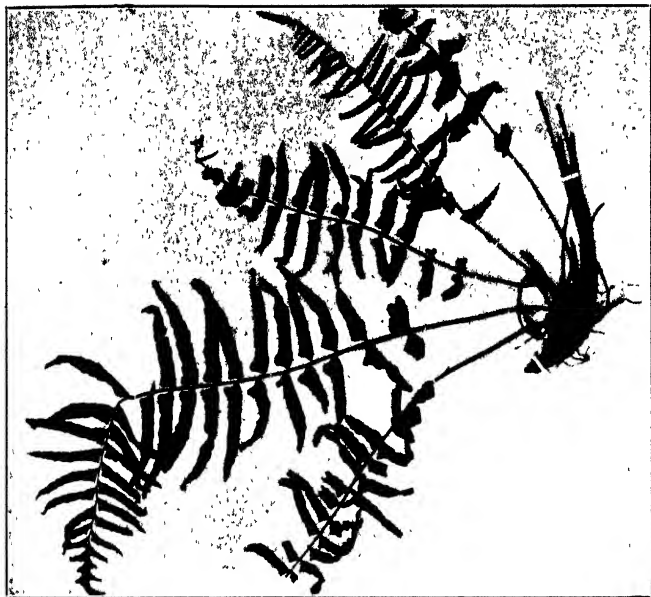
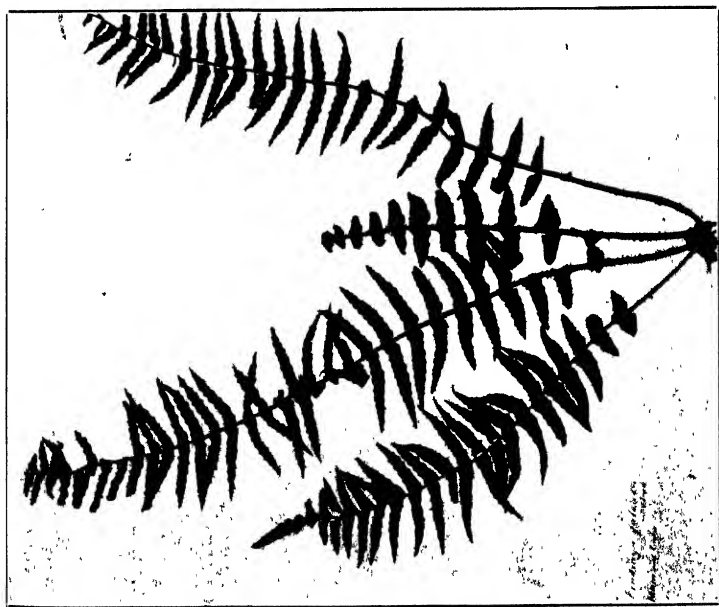


A



B

PLATE 3.—*Diellia Alexandri* (Hillebrand) Diels: A, length of frond in center of plant without stipe 11 $\frac{3}{4}$ inches, stipe 1 $\frac{1}{2}$ inches (B. P. Bishop Museum); B, unaccompanied by data, length of frond in center of plant without stipe 10 $\frac{1}{2}$ inches, stipe 2 $\frac{1}{2}$ inches (Smith College).



B

PLATE 4.—*Diellia*: A, plant labeled "*Lindisaya falcata* Hook., Maui and Oahu," length of longest frond without stipe 13½ inches, stipe 2¼ inches (note difference in shape of pinnae of youngest and older fronds) (B. P. Bishop Museum); B, *Diellia* from Kawaihapai, Oahu, collected by LeRoy Topping, length of longest frond without stipe 10½ inches, stipe 4 inches (note difference in pinnae of youngest frond and one next to it) (Smith College).

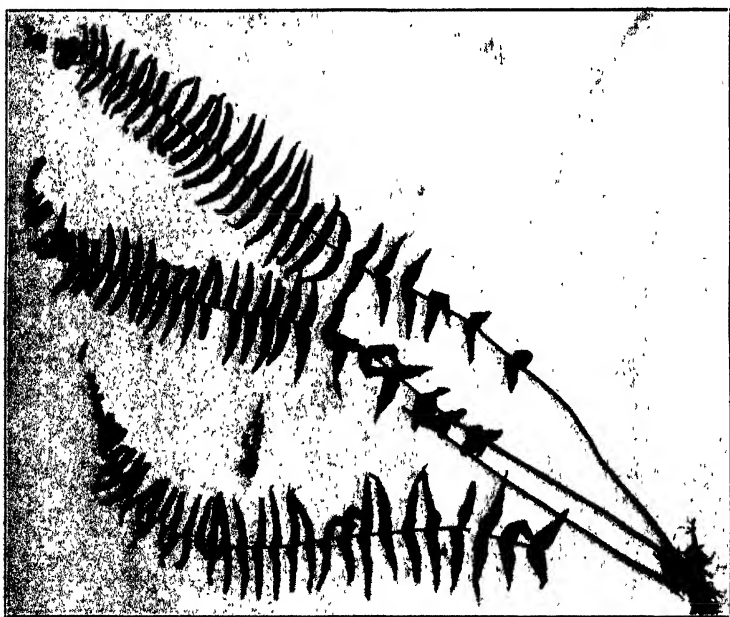
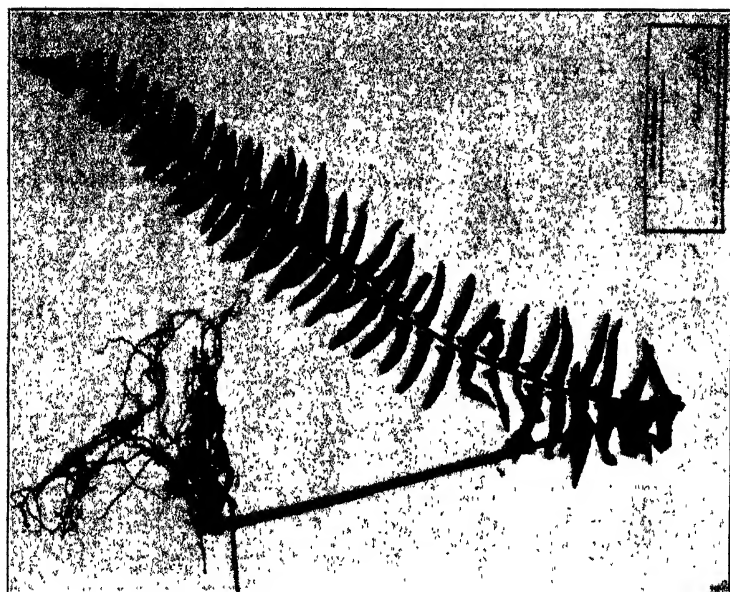
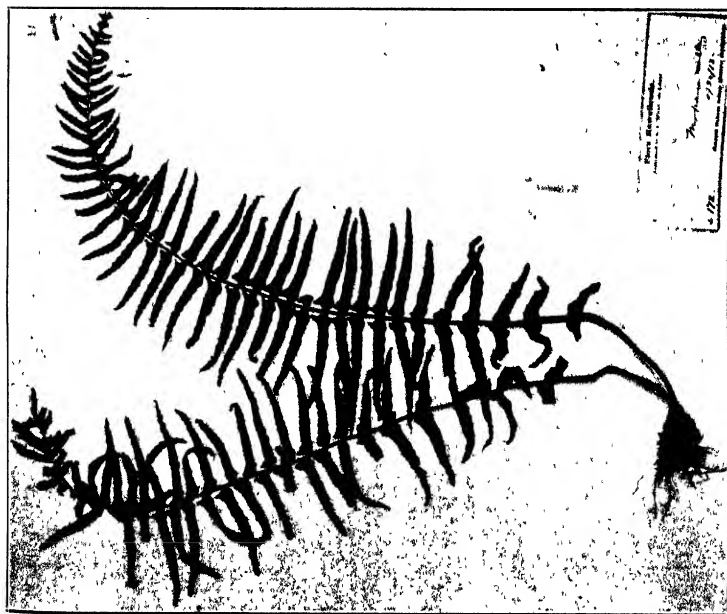


PLATE 5.—*Diellia*: A, plant from island of Hawaii (G. W. Russ, no. 36), probably *D. erecta*, not *D. falcata*, length of frond without stipe 12-13 inches, stipe 5 inches, no scales (B. P. Bishop Museum); B, plant from Pelekunu, Molokai, labeled "*Diellia falcata*" (Forbes, no. 584) but without scales and with too long a stipe for that species, length of frond without stipe 19½ inches, stipe 7 inches (B. P. Bishop Museum).

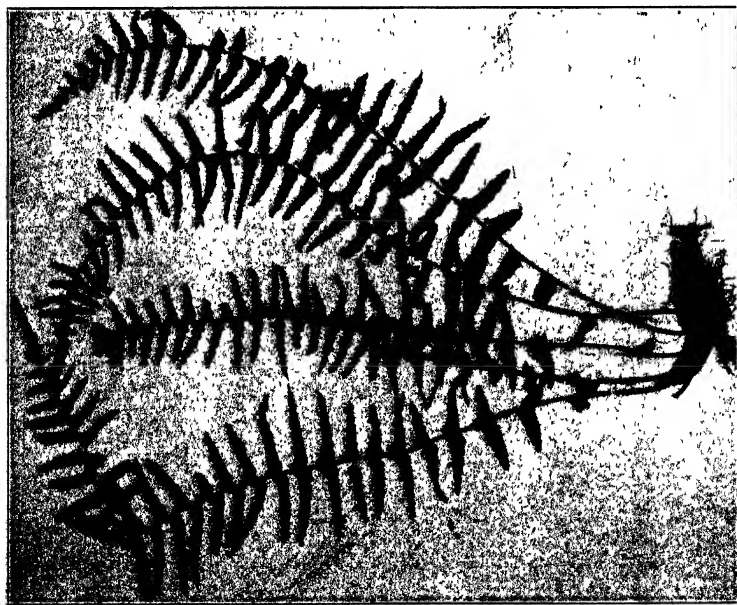


A

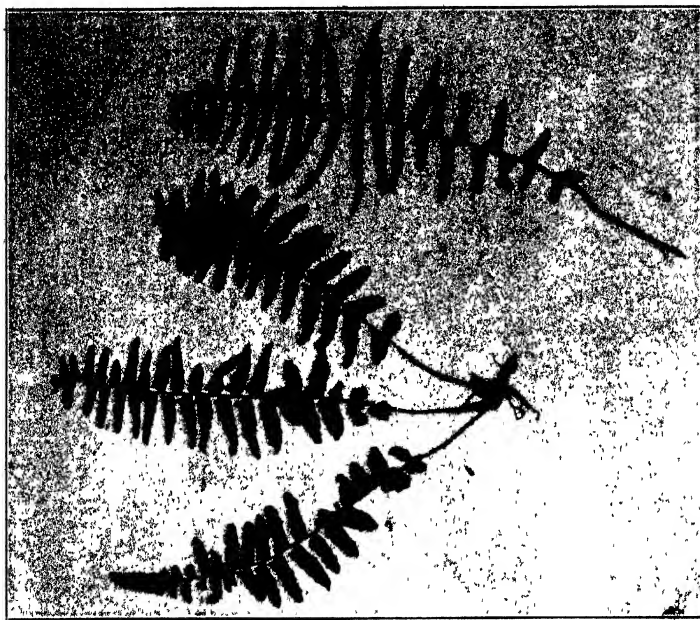


B

PLATE 6.—*Diellia*: A, plant from Mahana Valley, Lanai (G. C. Munro, no. 172) labeled "*Diellia*", length of fronds without stipes $12\frac{1}{4}$ and $14\frac{1}{2}$ inches, stipe of each $3\frac{3}{4}$ inches, note coenosori (B. P. Bishop Museum) ; B, *Diellia pumila* (?) from Pohakea Pass, Oahu, collected by LeRoy Topping, length of longest frond including stipe 7 inches (Smith College).



A



B

PLATE 7.—*Diellia* from Lanai showing variation in fronds: A, length of longest frond without stipe 16 inches, stipe 3 inches, no scales evident in either specimen (Smith College); B, length of fronds without stipes 7-8 inches, stipes 2-2½ inches (Smith College).

**A NEW CHAETOMOSILLUS FROM
NEW GUINEA**

(Diptera: Ephydriidae)

By

JOHN R. MALLOCH

BERNICE P. BISHOP MUSEUM

OCCASIONAL PAPERS

VOLUME X, No. 17

**HONOLULU, HAWAII
PUBLISHED BY THE MUSEUM**

May 12, 1934

A NEW CHAETOMOSILLUS FROM NEW GUINEA

(DIPTERA: EPHYDRIDAE)

By JOHN R. MALLOCH

The genus *Chaetomosillus* is known only from Formosa, China, and northwest India and was erected for the reception of *Mosillus dentifemur* Cresson by Hendel in 1933.¹ Up to the present only the genotype is known but below I describe a second species and extend the distribution of the genus to New Guinea.

Chaetomosillus nigriceps, new species.

Female

A small glossy black species, with no grey dusted marks on the face, which character distinguishes it from the genotype.

Length, 1.5 mm.

Head entirely glossy black, the triangle more polished than the parts of the frons laterad of it which are slightly brownish dusted, the face entirely polished except a slight tinge of brownish dust along the extreme lateral edges; antennae and palpi black. Frons partly denuded but apparently bristled as in the genotype. Hairs on upper side of the arista about three times as long as its basal diameter at base, becoming shorter to apex, but much longer than in *Mosillus dentifemur*.

Thorax glossy black. Scutellum somewhat swollen, apex evenly rounded and quite high, with two apical bristles situated on small wart-like elevated bases and placed close to the lower edge.

Legs black, basal three segments of each tarsus fulvous yellow. Armature of the fore femur much as in *M. dentifemur*, but without serration beyond the median tooth and with much finer ventral hairs. Fore coxae with quite dense but rather short fine black curled hairs at apices.

Wings greyish hyaline, veins black, second section of costa fully twice as long as the next two combined, the split just in front of first vein in costal vein very feebly developed, in fact apparently lacking. Halteres dull yellow.

New Guinea: Minjemfluss, Kaiser Wilhelmsland, R. Schlechter, holotype.

Type in the collection of the Deutsches Entomologisches Institut, Berlin-Dahlem, Germany.

The scutellum is entirely different in structure from that of *Mosillus dentifemur*, and the orbital and lateral facial bristles are reduced to very fine setulae or hairs, much weaker than in the genotype.

¹ Arch. f. Zool., 25-A, no. 21, p. 14.

NEW NEMERTEANS FROM HAWAII

By

W. R. COE

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NEW NEMERTEANS FROM HAWAII

By W. R. Coe

OSBORN ZOOLOGICAL LABORATORY, YALE UNIVERSITY

In contrast with the continental coasts and islands of more northerly latitudes, the shores and off-shore waters of the tropical and subtropical coasts bordering the Pacific Ocean have but a sparse representation of nemerteans. Only three species, of which two belong to the genus *Baseodiscus* and one (as yet undescribed) to *Drepanophorus*, have been previously recorded from Hawaii.¹ All of these were taken by the dredge in the vicinity of the islands.

Collections from the intertidal zone along the shores and reefs have been made by Dr. H. C. Edmondson during the past few years. These contain, in addition to the two species of *Baseodiscus* (*Taenio-soma*) reported from the off-shore waters, one hitherto undescribed species of the same genus and one new species of *Lineus*. Both of these show a number of morphological peculiarities which seem to be of sufficient zoological interest to warrant their publication at this time.

The genus *Baseodiscus* Diesing includes the most numerous and widely distributed species of all the nemerteans inhabiting the tropical and subtropical seas. They are found around the entire circumference of the earth. Only a few of the described species of the genus extend north or south along the continental shores beyond 40 degrees latitude. Species of the genera *Lineus* and *Drepanophorus*, on the contrary, are found in all latitudes.

***Baseodiscus edmondsoni*, new species (fig. 1).**

External Features

Body slender, rounded anteriorly; upwards of 100-500 mm in length but seldom more than 1-3.5 mm in diameter.

Head variable in shape according to state of contraction; pointed or rounded; truncate when the tip is fully withdrawn in the spasmodic contraction which occurs during preservation; more or less completely demarcated from body by transverse folds and the pair of oblique cephalic grooves.

Ocelli small, numerous, situated in an elongated group on each side of head, bending toward median line posteriorly; each group containing upwards of 15 ocelli posterior to the transverse pigment band on head and 20 or more on antero-lateral margin.

¹ Coe, W. R., Nemerteans of the Hawaiian islands collected by the steamer "Albatross" in 1902: U. S. Fish. Com., Bull., 1903, pp. 975-986, 1906.

Mouth varies from a circular pore to an elongated slit, according to state of contraction.

Color. Ventral and lateral surfaces of body and anterior margin of head pale yellowish or flesh-color; dorsal surface in anterior half of body marked by a broad median stripe of deep reddish brown, with more or less distinctly alternating bands of darker and lighter shades. Near posterior end of foregut region the dorsal pigment stripe becomes broken into a series of narrow transverse bands joined together in the median line by a slender continuation of the longitudinal band. The pigment stripe broadens in the head region and terminates abruptly anteriorly. A single transverse band of the same brown color lies on the dorsal surface of the head above the brain; this is separated from the main dorsal stripe by a broad band of white. In some specimens the median stripe is narrower, with 20-30 narrow transverse bands of much deeper color extending laterally on each side, while in others it is of more uniform width.

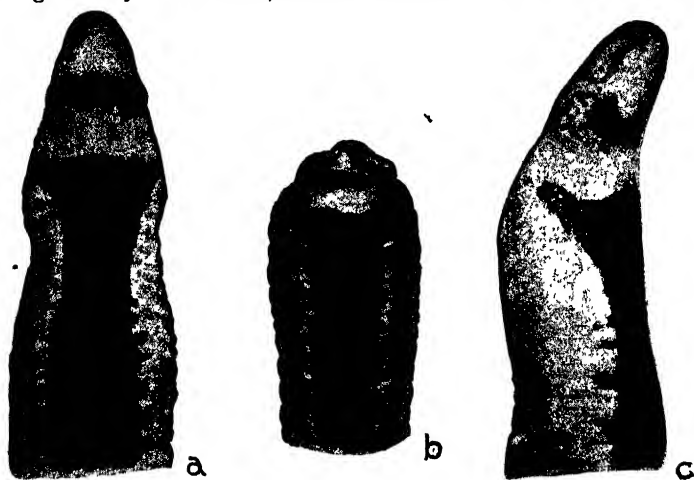


FIGURE 1.—*Baseodiscus edmondsoni*, new species: *a*, dorsal view of anterior end of body, showing positions of ocelli and extent of pigment band and stripe; *b*, same for strongly contracted specimen; *c*, lateral surface of anterior end of body in fully extended condition.

Internal Anatomy

Specimens studied after clearing in oil and later after being cut into serial sections show the following peculiarities of internal anatomy:

Body walls. Epidermis with usual arrangement of ciliated, glandular, and sensory cells. Basement membrane thick, with cup-shaped elevations and ridges for securing attachment of epidermis. Epidermal musculature of thin outer circular and inner longitudinal layers. Cutis unusually thick; outer portion with closely packed glands arranged in clusters; with common duct from each cluster to surface of epidermis; inner portion of cutis consists of dense connective tissue with fibrous branches extending externally to give support to the cutis glands and internally to hold in place the bundles of the outer longitudinal musculature. The connective layer is less than half as thick as the glandular layer.

Cephalic glands very extensive; principal opening terminal, above rhyncho-deal opening; continuous with intermuscular glands in anterior portion of foregut region. In ventral half of body in the foregut region the intermuscular glands become so closely placed as to separate the outer longitudinal muscular layer into outer and inner portions. Some of these glands extend entirely through this musculature and rest upon the outer surface of the nerve-plexus layer.

Dorso-ventral muscles well developed in posterior half of body, particularly near posterior extremity, as thin bands of muscles which lie close against anterior and posterior borders of intestinal diverticula. The two members of each pair of bands on each side of the body become separated as the gonads increase in size and evidently serve not only in flattening the body in the midgut region but may also aid in the discharge of the mature gametes.

Proboscis sheath and proboscis. The proboscis is small and short, being attached to the dorsal wall of the sheath near the anterior end of midgut region. The longitudinal muscle fibers of the retractor interlace with the longitudinal fibers of the sheath. The proboscis sheath is less than one third the length of the body, ending blindly in the connective tissues above the anterior portion of the midgut. In its posterior third it is held in place by branches of the dorso-ventral musculature.

Blood-vascular system. The usual cephalic lacunae unite to form a pair of large lateral lacunae posterior to the brain and these branch into a complex network of lacunae in the mouth region. These lacunae surround the foregut on all sides except in the dorsal area which is occupied by the proboscis sheath. At the posterior end of the foregut region the lacunae unite again into the pair of lateral vessels which continue to the posterior end of the body. The dorsal vessel leaves the proboscis sheath in the mouth region and joins the lateral vessels at the posterior end of the body.

Nephridia. The excretory system extends nearly the entire length of the foregut region. The terminal organs project freely into the lumens of the blood lacunae beneath and beside the foregut to form conspicuous nephridial glands, which in many places occupy fully half the diameter of the blood spaces. The efferent ducts are numerous, some of them leading to the dorsolateral surfaces of the body, while others open directly into the foregut as in *B. cingulatus* and a few other species of the genus.

Nervous system. The cerebral ganglia are unusually massive as compared with the size of the body; the dorsal nerve is also relatively large and the nerve-plexus, which extends around the entire circumference of the body between circular and outer longitudinal muscular layers, is much thicker than in most species of the genus.

Sense organs. The cerebral sense organs are voluminous, with relatively large canals leading to the ventrolateral surfaces of the head. The ocelli are highly differentiated, each having a pigment cup beneath a well-demarcated lens. The optic nerves are correspondingly large and conspicuous. Organs of similar structure but without pigment cups are also present; these are considered imperfectly developed ocelli. The spindle-shaped sensory cells of the epidermis are also highly differentiated, especially on the head, where the epidermis reaches an unusual thickness.

Parasites. Both specimens sectioned contained slender nematode-like parasites in cysts in the connective tissue between lateral nerve cord and epithelium of the midgut, as well as many elongated gregarines in the intestinal lumen.

Known only from the Hawaiian islands, where specimens were obtained by C. H. Edmondson at Wake Island and at Kaaawa and Kahala, Oahu, and by A. E. Verrill at Lihue, Kauai.

Baseodiscus univittatus (fig. 2).

Taeniosoma univittatum Coe: U. S. Fish Com., Bull., 1903, p. 978, 1906.

Individuals of this species are easily distinguished by the single stripe of dark reddish-brown pigment which extends the entire length of the dorsal surface. Elsewhere the body is creamy white or flesh-colored. The species differs from most others of the genus in the inconspicuousness or absence of ocelli. In only one specimen could a few minute and irregular pigment spots be detected.

The species resembles *B. unistriatus* (= *Eupolia unistriata* Isler) from the Indian Ocean in having a single dorsal stripe, but differs in several morphological peculiarities.

The body is slender in life, with a length of upward of 100 mm and a diameter of 1.5-2 mm. Strongly contracted specimens measure 20-30 mm in length and 2-3 mm in diameter.

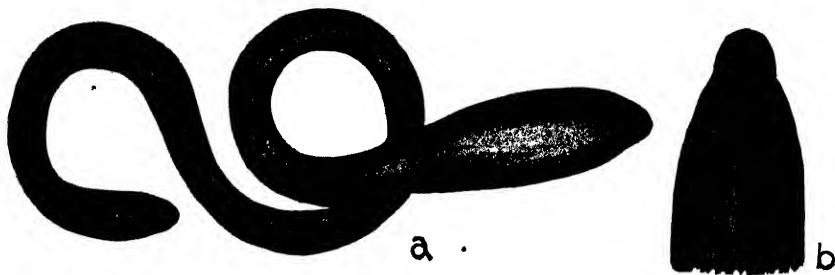


FIGURE 2.—*Baseodiscus univittatus* (Coe): a, body of cotype of variety with narrow dorsal stripe, strongly contracted; b, dorsal view of anterior end of body.

Specimens collected by C. H. Edmondson on the reefs of Oahu, one from Kaaawa and one from Waikiki.

Previously reported by Coe from depths of 250 to 260 meters off the southern coast of Molokai and from about the same depth north of Maui.

Baseodiscus cingulatus (fig. 3).

Taeniosoma cingulatum Coe: U. S. Fish. Comm., Bull., 1903, p. 981, 1906.

This species is easily distinguished by the numerous narrow rings of dark reddish-brown pigment which contrast sharply with the pale yellowish or flesh-colored tone of the rest of the body. Large individuals often have more than a

hundred of these rings situated at irregular intervals throughout the length of the body. Frequently the rings are even narrower on the ventral than on the dorsal surface and in some individuals many of them are incomplete on the ventral surface. Between the more sharply demarcated rings may be others which are so faintly pigmented as to be scarcely discernible.

Individuals of this species grow to a relatively large size, sometimes exceeding a meter in length, but the body is comparatively slender except when strongly contracted. One of the specimens measured 475 mm in length after preservation, with a diameter of about 4 mm in the anterior part of the body, but was scarcely more than 1 mm wide toward the posterior end.

On each lateral margin of the head are 35 to 50 ocelli; these are difficult to distinguish when the head is strongly contracted.

The nephridial system differs from that found in most nemerteans in having some of the efferent ducts leading to the lumen of the foregut, whereas others open on the dorso-lateral surfaces of the body as is more characteristic for members of this genus.

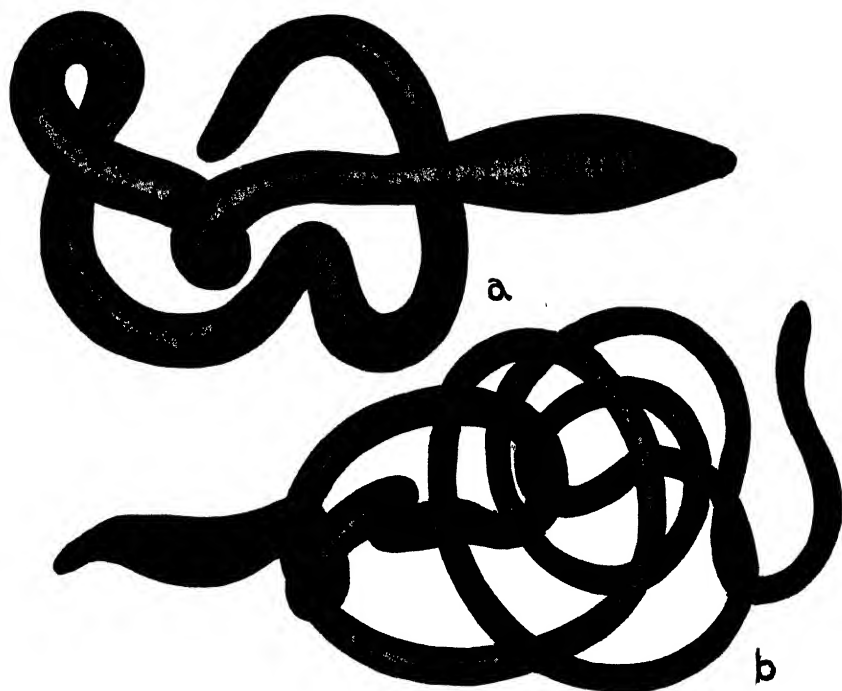


FIGURE 3.—*Baseodiscus cingulatus* (Coe): *a*, variety with irregular and incomplete transverse pigmented rings, body rather strongly contracted; *b*, variety with regular, sharply demarcated rings of pigment.

Previously dredged from depths of 40 to 80 meters in the channel between Maui and Lanai. In the collections sent by C. H. Edmond-

son are specimens from Kahala, Malaekahana, and Kaaawa, Oahu, and from Necker Island.

***Lineus albifrons*, new species (fig. 4).**

A single specimen of an apparently new species with characteristic color pattern was found in the collection sent by C. H. Edmondson. Although the precise hue of the deeply pigmented anterior end of the body can not be stated, the white or colorless anterior tip will presumably make the worms easily recognizable in life.

Body slender, rounded anteriorly, somewhat flattened in posterior half of body; single known specimen 14 mm long and 1.5 mm in diameter after preservation.

Color of preserved specimen indicates a deeply pigmented anterior third of body, sharply demarcated anteriorly by a colorless area at the extreme anterior end. Posteriorly the amount of pigment decreases gradually, giving the midgut region a much paler coloration. Pattern similar but paler on ventral surface.



FIGURE 4.—*Lineus albifrons*, new species: dorsal and ventral aspects of anterior end of body, showing extent of terminal unpigmented area.

Cephalic grooves of moderate length, but not deep; rhynchodeal opening subterminal; mouth situated immediately behind posterior ends of cephalic grooves.

Ocelli inconspicuous or wanting.

Proboscis sheath extends through fully half the length of the body. Proboscis large; musculature composed of three layers anteriorly, in addition to a thin external layer of circular or oblique fibers. In the posterior half of the proboscis the inner longitudinal musculature gradually disappears; muscular crosses are found not only between the two circular musculatures but also between the two layers of longitudinal fibers.

Body white, cephalic glands, and frontal sense organs as in related species. Cutis thin, the glandular layer limited to outer portion of outer longitudinal

musculature; pigment granules scattered in outer portion. Dorso-ventral muscles well developed posteriorly.

Brain and cerebral sense organs large; cephalic, buccal, and proboscicidal nerves conspicuous.

Cephalic blood lacunae lead to communicating lacunae surrounding foregut, with larger lateral vessels beside proboscis sheath. Dorsal vessel remains in rhynchocoel through most of foregut region.

Nephridia limited to middle of foregut region; embedded in dorso-lateral walls of lateral blood lacunae and projecting freely into the blood spaces. A single pair of large efferent ducts leads to dorso-lateral surfaces of body near posterior ends of the pair of nephridial glands.

Known from only a single specimen collected at Kahala, Oahu.

The color pattern of individuals of this new species, with deeply pigmented anterior third of body and sharply demarcated colorless tip, is evidently similar to that of *Cerebratulus albifrons* Coe, which is found along the Pacific coast of North America from Alaska to southern California. The resemblance is superficial, however, for the generic distinctions are obvious.

Drepanophorus species.

At least one species of *Drepanophorus* is present in the off-shore waters of Hawaii. It has not yet been identified.

Tetrastemma species.

A species of the genus *Tetrastemma* collected by A. E. Verrill on the reef at Lihue, Kauai, is not available for study. The body in life is uniformly flesh-colored and without distinctive markings.

**TAXONOMIC STUDIES OF RAIATEAN
PLANTS**

By

JOHN WILLIAM MOORE

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TAXONOMIC STUDIES OF RAIATEAN PLANTS

By JOHN WILLIAM MOORE

BOTANICAL NAME OF THE POLYNESIAN AVA

Specimens of the ava, awa, kava, or kawa and other *Pipers* were brought back by J. R. and G. Forster on their return at the end of the second voyage of Captain James Cook. The first Latin name of the ava was *Piper methysticum*. A description was given by Georg Forster (3, p. 76)*:

P. foliis cordatis acuminatis multinerviis: spicis axillaribus solitariis brevissimis, pedunculatis, patentissimis.

This is a good description of the plant, and *Piper methysticum* was undoubtedly the valid name for the ava until the recent change in the rules of nomenclature, ruling out homonymns. The difficulty is that the same binomial had been used five years earlier by the younger Linnaeus for a different plant, and if it can be shown that Linnaeus' name was then validly published it becomes unavailable for further use for any other plant.

The younger Linnaeus (6, p. 91) apparently had received specimens of a *Piper* from the Forsters and published his observations. He described the plant as *Piper methysticum* with the following diagnosis:

P. foliis cordatis multinerviis petiolatis, spicis axillaribus pedunculatis plurimis.

This appears on the surface to be a perfectly valid publication and it would undoubtedly be such were it not for an entry among the "emendanda" at the end of the same work (6, p. 468, not numbered): "Pag. 91. *Piper methysticum* lege *Piper latifolium*." This raises the question of the right of an author to change a name by means of an emendation published simultaneously with the original description. As the rules do not recognize page priority, it seems that the work must be considered as a whole and that the emendation must be applied before reading the emended paragraph. Linnaeus' "*Piper methysticum*", then, disappears entirely, and his description (6, p. 91) reads "*Piper latifolium*. *P. foliis cordatis, etc.*", and leaves the way clear for Forster's use of the name *P. methysticum*.

* Numbers in parentheses refer to Literature Cited, p. 8.

Forster himself was aware of Linnaeus' use of the name *Piper methysticum*, for in his discussion of the ava (3, p. 76) he makes the caustic comment :

Species caute distinguenda a *Pipere latifolio* quod in Supplem. plantar. 91, nescio quo casu *Piper methysticum* vocatur. Etenim non solum notis botanicis plurimis a vero *Pipere methystico*, latifolium illud discrepat, sed etiam toxica qualitate caret, neque in hunc usum ab incolis unquam adhibetur, sponteque nascit per omnes fere insulas oceani australis intra tropicos sitas.

If this line of reasoning is correct, *P. methysticum* G. Forster remains as the valid name; otherwise there appears to be no valid name to date.

In 1917, Farwell (2, p. 230) tried to clear the nomenclature of ava. In his article he proposed that the name *Piper methysticum* Linnaeus f. (6, p. 91) be applied to the plant called *Piper latifolium* by Linnaeus f. and by G. Forster and most subsequent authors, and that the name *Piper esculentum* (Rafinesque) Farwell be used for the ava plant. Such a procedure would not only result in utter confusion, but it is strictly contrary to the rules of nomenclature. Even if one assumes that *Piper methysticum* was validly published by Linnaeus f., so also was *Piper latifolium*, for the reference in the "emendanda" refers to a diagnosis under another name. As there is here no priority of publication, it remained for the first author who combined them to choose which name he would use. Probably Linnaeus himself did this in the "emendandum," and certainly Forster did five years later in no uncertain terms. It is apparent from the quotation already cited that G. Forster in 1786 by chance or otherwise used the name *P. latifolium* for the same species as that published by Linnaeus f.

Forster's description (3, p. 76; 4, p. 5) is essentially the same as Linnaeus' description (6, p. 91). There is no reason therefore for not accepting *Piper latifolium* Linnaeus f., as emended (6, p. 468), as the first valid publication of a name for the plant in question. Before leaving the name *Piper latifolium*, however, an examination of the use of the binomial by subsequent authors is highly desirable.

Piper latifolium Lamarck: Illustr., vol. 1, p. 81, 1791, is *Piper subpeltatum* Willdenow: Sp. Pl., vol. 1, p. 166, 1798.

Piper latifolium Hunter: in As. Res., 9, p. 390, 1809, is *Piper sarmentosum* Roxburgh: Flora Indica, vol. 1, p. 160, 1820.

Piper latifolium Jacquin is an erroneous citation of Haworth in his Syn.

Pl. Succ., p. 3, 1812. This error was carried on by Steudel in his Nomenclator, ed. 1, pp. 624, 626; ed. 2, vol. 2, pp. 303, 341. There exists no publication of the binomial *Piper latifolium* Jacquin.

Farwell's grounds for the name *Piper esculentum* (Rafinesque) Farwell for the ava are also not well founded. An examination of Rafinesque's *Methysticum esculentum* (9, p. 85) shows the name was not there validly published. Rafinesque's statements are as follows:

500. CARPUPICA Raf. probably another G. type of *C. odorata* Raf. Piper carpupija RP. tree of Peru with fragrant leaves—Piper methysticum and Churumaya are also probably types of other Genera ? to be called *Methysticum esculentum* Raf. and *Churumaya arborea* Raf. Is not Piper betel another? to be called *Betela mastica* Raf.

There is no reference to a previous publication of *Piper methysticum* as no author is cited. Two different plants—*Piper methysticum* Georg Forster and *Piper methysticum* Roxburgh (Flora Indica, vol. 1, p. 159, 1820, which is *Piper majusculum* Blume Verh. Bot. av. Gen., XI, p. 210, 1826)—had been published under the name *Piper methysticum* at the time Rafinesque's Sylva (9) appeared. One can only say that the Rafinesque name is a *nomen nudum* and that its application is very uncertain if at all intelligible. Other names of interest for the sake of completeness may be mentioned. Miquel (7, p. 36) gives the name *Piper inebrians* Bertero: Mss. The name applies to the ava but was placed under synonymy by Miquel, and this does not constitute publication. Miquel also cites as a synonym "*Piper spurium* Forst. in Mus. Paris herb."

Royale (10, p. 333) uses the name *Piper inebrians* in his discussion of Piperaceae. The name is merely mentioned without description and is a *nomen nudum*. Kew Index also makes mention of the fact that *Piper kava* is found in the index of Royale's work, but this name, of course, has no standing.

The above review of the literature leads to the conclusion that the valid name for the ava plant is none other than *Piper methysticum* Georg Forster.

I am grateful for the transcripts of certain descriptions furnished me during the preparation of this note by members of the Gray Herbarium staff, and to John Hendley Barnhart of the New York Botanical Garden for the information concerning the name *Piper latifolium* Jacquin.

NOMENCLATORIAL TRANSFERS

Bonnierella reflexa (John W. Moore), combinatio nova.

Polyscias reflexa John W. Moore: B. P. Bishop Mus., Bull. 102, p. 35, July 20, 1933.

I followed Harms (1, p. 45) in placing the Raiatean species in the genus *Polyscias*, as it is unquestionably a near relative of *Polyscias tahitensis* (Nadeaud) Harms (1, p. 45) (*Aralia tahitensis* Nadeaud) (8, p. 63).

The genus *Bonnierella* to which the congeneric species from Tahiti belongs was described by Viguier (11, p. 314). He segregates the Tahitian species as the type of a new genus, *Bonnierella*, upon what appears to be sufficient grounds, and his genus is accepted by Krause (5, p. 220). As the two species are undoubtedly congeneric, the transfer of the Raiatean species is necessary.

Inga Ynga (Vellozo), combinatio nova.

Mimosa Ynga Vellozo: Florae fluminensis, t. 3, p. xi, 1825.

Inga edulis Martius: Flora, vol. 20, Beibl. 2, p. 113, 1837.

The plant called *Inga edulis* by Martius was originally published as *Mimosa Ynga* by Vellozo. Martius first rightly placed the species in the genus *Inga*, but changed the specific name to *edulis*, supposedly because he did not wish to establish a nearly duplicate name. According to the international rules the generic and specific names can not be absolute duplicates. The rulings at the last meeting of the international Botanical Congress upheld this stand. The specific name *Ynga* can in no sense be construed as identical with *Inga*. It therefore becomes necessary to restore the original specific epithet of Vellozo.

Boerhaavia acutifolia (Choisy), species nova.

Boerhaavia diffusa Linnaeus varietas *acutifolia* Choisy: in De Candolle, Prodrumus, pars 3, sect. post., p. 453, May 5, 1849.

Choisy in his treatment of *Boerhaavia* in the Prodrumus construed the Linnaean species in a very broad sense. The elements which he included under *Boerhaavia diffusa* and listed as varieties are altogether inharmonious. The broad- and obtuse-leaved, large-fruited plant of Linnaeus from India can not well be combined with the common Polynesian species with its lanceolate, acute, sharply apiculate leaves,

more slender peduncles, and smaller fruits. The acute-leaved species occurs also in tropical Australia and Java.

NEW SPECIES

Ascarina raiateensis, species nova.

Frutex 1 m. altus, rami crassiusculi glabri patentes teretes rufo-fusci internodiis 1-3 cm. longis instructi, laminae 4-5½ cm. longae 2½-3 cm. latae obovatae apice rotundatae submarginatae ad basin cuneatae in petiolos 2-3 mm. longos connatos et poculum truncatum 2-2½ mm. altum facientes attenuatae supra virides nitidae infra pallidiores parte 2/3 superiore crenatae paribus nervorum secundariorum 10 instructae, inflorescentia staminifera ignota, inflorescentia pistillifera racemosa cum spica solitaria terminali et spicis axillaribus binis divaricatis e nodis superioribus, spicis omnibus ad 4 cm. longis robustis, bractae inferiores foliaceae superiores in poculum redactae, pedunculi plerumque haud ramosi, flores singuli in axillis bractearum late ovatarum obtusarum 3-dentatarum lati bracteolis binis parvis subquadratis instructi, ovarium 1¼ mm. longum 1 mm. latum ovoideum, stigma plagiotropum 2-labiatum persistens, fructus (immaturus) 1¾ mm. longus 1½ mm. latus ellipsoideus.

Raiatea: Temehani Plain, in moist soil, altitude 400 meters, October 7, 1926, J. W. Moore, no. 178. Endemic.

Ascarina raiateensis differs from *Ascarina polystachya* J. R. and G. Forster in having smaller leaves with shorter petioles, stouter, shorter spikes with the fruits closely aggregated, not distantly placed. and a distinctly bilobed stigma.

Loranthus raiateensis, species nova.

Frutex glabrus ad 1 m. altus in ramulis arborum parasiticus, caules teretes cortice castaneo instructi, rami teretes arcuati lignei fusco-virentes, folia opposita petiolata, laminibus 6-7 cm. longis 3-4 cm. latis ovatis obtusis integris subaequilateralibus ad basin cuneatis coriaceis flavo-viridibus laevibus obscure nervatis nervis secundariis 6-7 utro latere costae instructis, petioliis 4-5 mm. longis teretibus supra canaliculatis, inflorescentiae axillares solitariae cymosae dimidiatae, pedunculus communis 7-17 mm. longus teres erectus, rachis 5-10 mm. longa, ramuli secundarii 2 mm. longi utrinque linea decurrente instructi, flores ternos ferentes quorum medius sessilis est, bini laterales in ramulis 1¼ mm. longis tolluntur floribus omnibus singulis singula bractea laterali 1½ mm. longa 1¼ mm. lata late ovata obtusa carnosa instructis, corolla in alabastro 24-26 mm. longa ad basin conspicue angulata 3 mm. lata supra expansa clavata subterete 2 mm. lata, calyx 5 mm. longus infra 2 mm. latus in parte libera expansa 2½ mm. latus truncatus dentibus 5 minutis instructus, pars libera 1 1/3 mm. longa tubulata, petalae 5 infra sulphureae supra aurantiacae apicibus subacutis vel rotundatis primum sub parte patente vel reflexa leviter cohaerentes in tubo 18 mm. longo mox liberae, petala singula ad basin 2 mm. lata in parte angustissima 1¼ mm. lata in parte patente vel reflexa 1 1/3 mm. lata, stamina

5 filamentis 20-23 mm. longis de 3 mm. superioribus liberis, antheris 3 mm. longis $\frac{1}{2}$ mm. latis linearibus acutis erectis flavis, stylus 27 mm. longus filiformis stigmatibus simplicibus obtusis obscure lobatis ovarium $2\frac{1}{2}$ mm. longum 1 mm. latum obovatum vel ellipsoideum, fructus ignotus.

Raiatea: parasitic on branches of trees, ridge, upper end of third valley south of Faaroa Bay, altitude 140 meters, January 13, 1927, J. W. Moore, no. 526. Endemic.

Loranthus raiateensis differs from *Loranthus Forsterianus* Presl ex Schulte in having broader, nearly equilateral leaves, larger and more closely aggregated flowers with a longer calyx and corolla.

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ANATOMY OF HAWAIIAN PEPEROMIAS

By

T. G. YUNCKER AND WILLIAM D. GRAY

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ANATOMY OF HAWAIIAN PEPEROMIAS

By T. G. YUNCKER AND WILLIAM D. GRAY

INTRODUCTION

The anatomy of the plants comprising the family Piperaceae presents several interesting features not common to other dicotyledonous families. This is especially true of the genus *Peperomia*, which includes several hundred species distributed in tropical and subtropical regions throughout the world.

During 1932-33, while making a taxonomic study of the genus *Peperomia* as represented in Hawaii,¹ the senior author collected and preserved in a 4 per cent formalin solution leaves and parts of stems of several species. No attempt was made to preserve material of all species found. Those collected, however, represent the three subgenera occurring in Hawaii, as follows: subgenus *Micropiper*—*Peperomia reflexa* Dietrich, *P. reflexa* Dietrich variety *parvifolia* C. deCandolle; subgenus *Sphaerocarpidium*—*P. oahuensis* C. deCandolle, *P. latifolia* Miquel, *P. membranacea* Hooker and Arnott, *P. leptostachya* Hooker and Arnott, *P. ellipticibacca* C. deCandolle, *P. Cookiana* C. deCandolle, *P. Cookiana* C. deCandolle variety *flavinerva* (C. deCandolle) Yuncker, *P. sandwicensis* Miquel; subgenus Hawaiiana—*P. lilifolia* C. deCandolle variety *nudilimba* (C. deCandolle) Yuncker, *P. Rockii* C. deCandolle, *P. hirtipetiolata* C. deCandolle variety *longilimba* (C. deCandolle) Yuncker, *P. expallescens* C. deCandolle. The species selected are presumably fairly representative of the genus as a whole as it is represented in Hawaii.

Though some work has been done on a few members of the genus, we have been unable to find reference to any study which has ever been made on the anatomy of any of the Hawaiian species. With the exception of *P. reflexa*, *P. leptostachya*, and perhaps also *P. oahuensis* and *P. membranacea*, the species discussed in this paper are endemic.

Sections 20 to 25 microns of the stems and leaves of each species were cut. They were bleached in chloral hydrate and mounted in balsam for study. Each species is represented by diagrams of

¹ Yuncker, T. G., Revision of the Hawaiian species of *Peperomia*: B. P. Bishop Mus., Bull. 112, 1933.

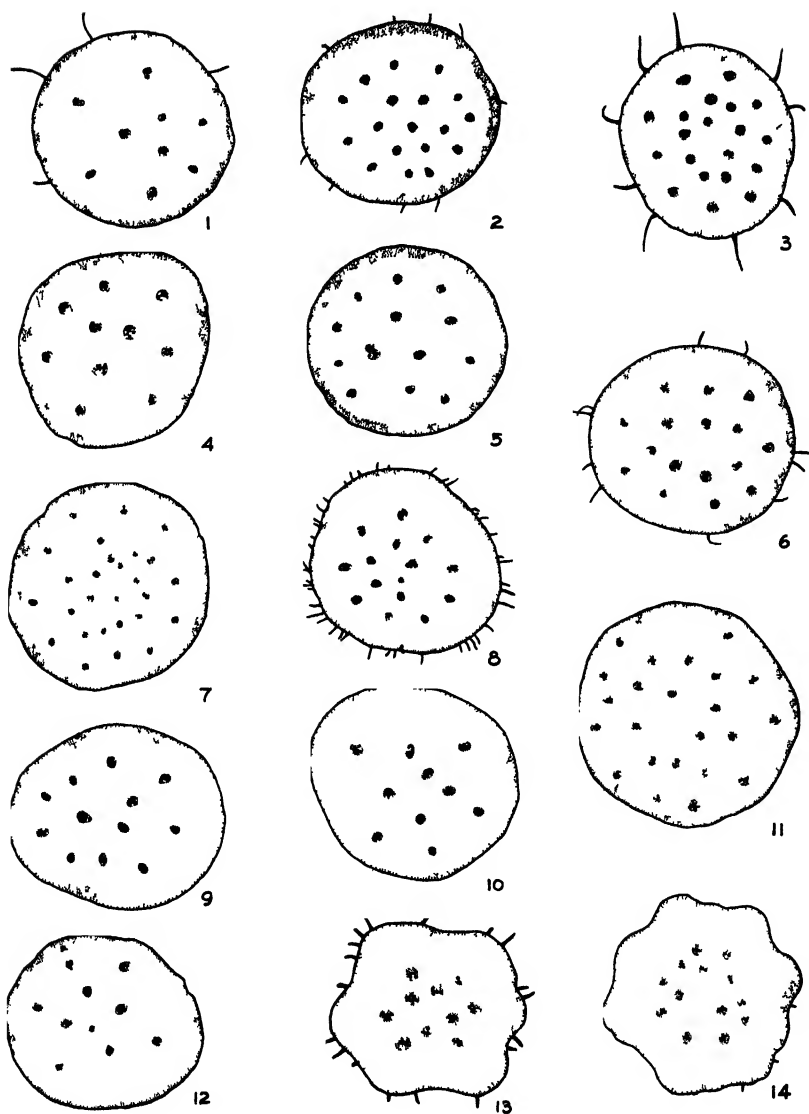
a cross section of an entire stem and of a leaf from the midrib to the margin. Details of the stems and leaves are illustrated in more highly magnified sections which show a vascular bundle and the tissues of the stem and cells from the upper to lower epidermis of the leaf. The diagrammatic drawings were made with the aid of a small Leitz projector and those showing cellular details by means of a Leitz microprojection apparatus. The measurements of the cells and tissues were taken, in the main, from the sections illustrated. Variations in details are to be expected in sections made of other leaves or at different stem levels. In general, the gross anatomical structures of both the leaves and the stems of all the species studied are similar.

STEMS

Epidermis. The epidermal cells of all the species examined are more or less uniformly rectangular in shape, as viewed in cross section, and they range in size from about 10 by 15 microns in *P. reflexa* variety *parvifolia* up to about 30 by 80 microns in *P. membranacea*. A definite amount of cutinization in the epidermis of *P. reflexa* and *P. reflexa* variety *parvifolia* results in cells of a slightly different shape from that in the other species. In *P. reflexa* the radial as well as the outer walls show considerable cutinization, but in *P. reflexa* variety *parvifolia* there is no cutinization of the radial walls. In the other species studied, the cuticle is thin and not especially conspicuous, excepting in *P. lilifolia* variety *nudilimba*, which exhibits cuticle to a somewhat less extent than *P. reflexa*.

Trichomes. Excepting *P. oahuensis* and *P. membranacea*, which are wholly glabrous, all the species discussed in this paper have hairs on the stems. In some of the species, however, the stems are hairy above but glabrate below, and the figured sections of some of these species are from the lower glabrate region and do not illustrate the hairs. The hairs are all multicellular and uniseriate, with the number of cells ranging from as few as 2 in *P. reflexa* to as many as 35 in *P. hirtipetiola* variety *longilimba*. The hairs are all slender and gradually taper from the base to a more or less acute apex. In length they range from about 0.1 mm in *P. reflexa* to 2.1 mm in *P. hirtipetiola* variety *longilimba*.

Collenchyma. All the stems show a definite and conspicuous layer of collenchymatous cells immediately beneath the epidermis.



FIGURES 1-14—Diagrams of stems 1, *P. Cookiana* ($\times 7$), 2, *P. Cookiana* variety *flavimerva* ($\times 45$), 3, *P. hirtipetiolata* variety *longilimba* ($\times 2$), 4, *P. oahuensis* ($\times 8$), 5, *P. expallescens* ($\times 5$), 6, *P. ellipticibacca* ($\times 4$), 7, *P. Rockii* ($\times 2$), 8, *P. leptostachya* ($\times 7$), 9, *P. sandwicensis* ($\times 5$), 10, *P. membranacea* ($\times 6$), 11, *P. lilifolia* variety *nudilimba* ($\times 25$), 12, *P. latifolia* ($\times 5$); 13, *P. reflexa* variety *parvifolia* ($\times 21$), 14, *P. reflexa* ($\times 12$)

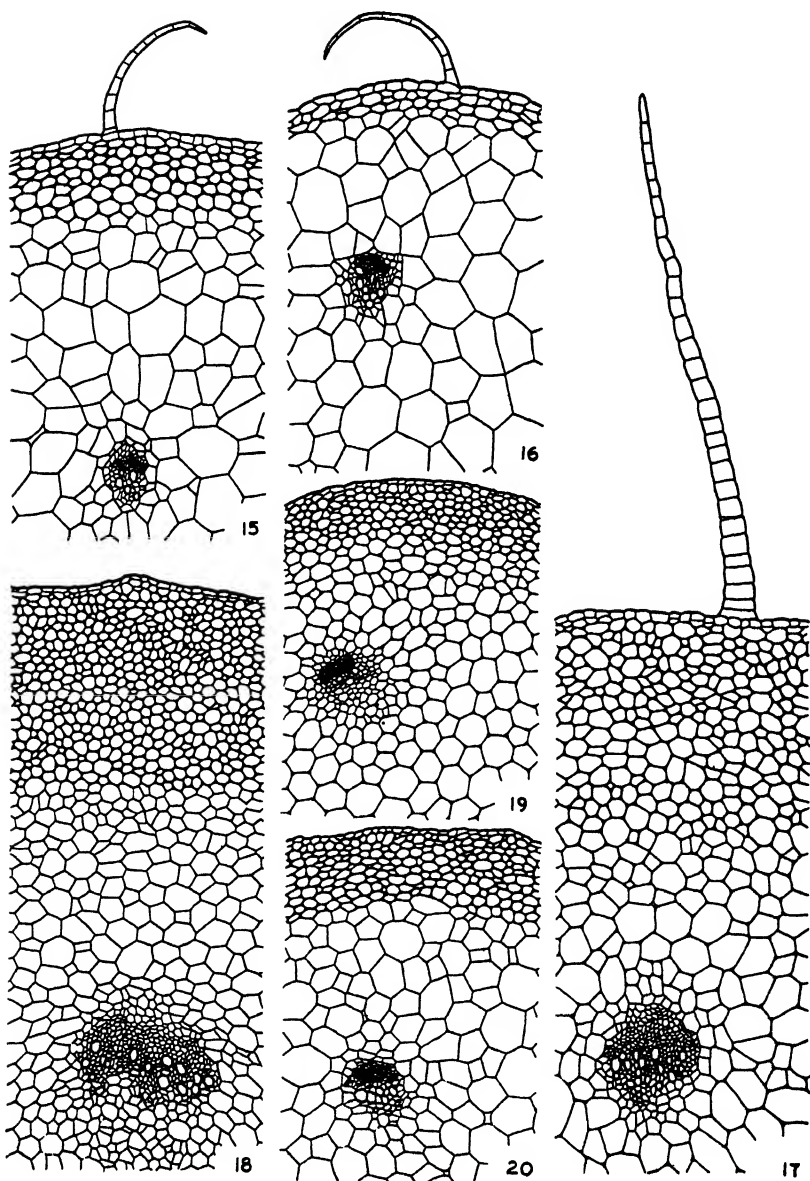
This layer ranges in thickness from 2 or 3 cells in *P. Cookiana* to 23 in *P. Rockii*. In *P. Cookiana* and *P. leptostachya* the collenchyma occupies only about one twelfth to one fourteenth of the diameter of the stem; in *P. reflexa* and *P. hirtipetiola* variety *longilimba* it occupies about one fifth of the diameter. The cells are similar in shape in the different species, but exhibit a wide variation in size.

Hydathodes. Hydathodes, less abundant but similar in structure to those on the leaves, were found in the epidermis of the stems of all the species.

Ground parenchyma. The ground parenchyma, in which are scattered the vascular bundles, is composed of parenchymatous cells of varying shapes and sizes. In *P. reflexa* and *P. leptostachya* well-defined and comparatively large intercellular spaces are present. In the other species, however, the intercellular spaces are lacking or, if present, are very small. Crystals of calcium oxalate are scattered throughout the ground parenchyma of most of the species. The crystals, which vary greatly in abundance in the different species, are for the most part of the druse type, but simple crystals are not uncommon. Starch grains, found throughout the cells of the ground parenchyma of all species, vary considerably in abundance. In *P. oahuensis* cells were found which are similar to the mucilage canals referred to by Solereder.²

Vascular bundles. In all the stems studied there is an outer more or less well-defined but irregular ring of vascular bundles surrounding an irregularly arranged central group of bundles. The bundles of the peripheral ring are foliar; the inner bundles are either basic central bundles or foliar bundles from leaves several nodes above the point where the section was made. The vascular bundles are surrounded by small, closely packed parenchyma cells. Solereder states that in some species each vascular bundle is either surrounded by an endodermis or else there is a semicircular endodermis around the bast, but in none of the species which we studied was any definite single layer found. The size and number of the bundles vary in sections taken from different internodes of the same stems as well as between the stems of different species. The tracheal tubes are mostly of the scalariform type, the annular and spiral types

² Solereder, Hans, Systematic anatomy of the dicotyledons, vol. 2, trans. by Boodle and Fritsch, Oxford, 1908.



FIGURES 15-20.—Details of stems ($\times 38$): 15, *P. Cookiana* variety *flavinnerva*; 16, *P. Cookiana*; 17, *P. hirtipetiola* variety *longilimba*; 18, *P. Rockii*; 19, *P. oahuensis*; 20, *P. expallescons*.

being less common. No pitted vessels were found in any of the material studied. Cambium was also lacking.

LEAVES

The leaves vary considerably in thickness and amount of mechanical tissue present. *P. reflexa* has the thickest leaves, *P. membranacea* the thinnest. The mechanical tissue is represented by layers of collenchymatous cells beneath the major veins. Some species, especially *P. reflexa* and *P. membranacea*, lack mechanical tissue, but the other species studied show varying amounts.

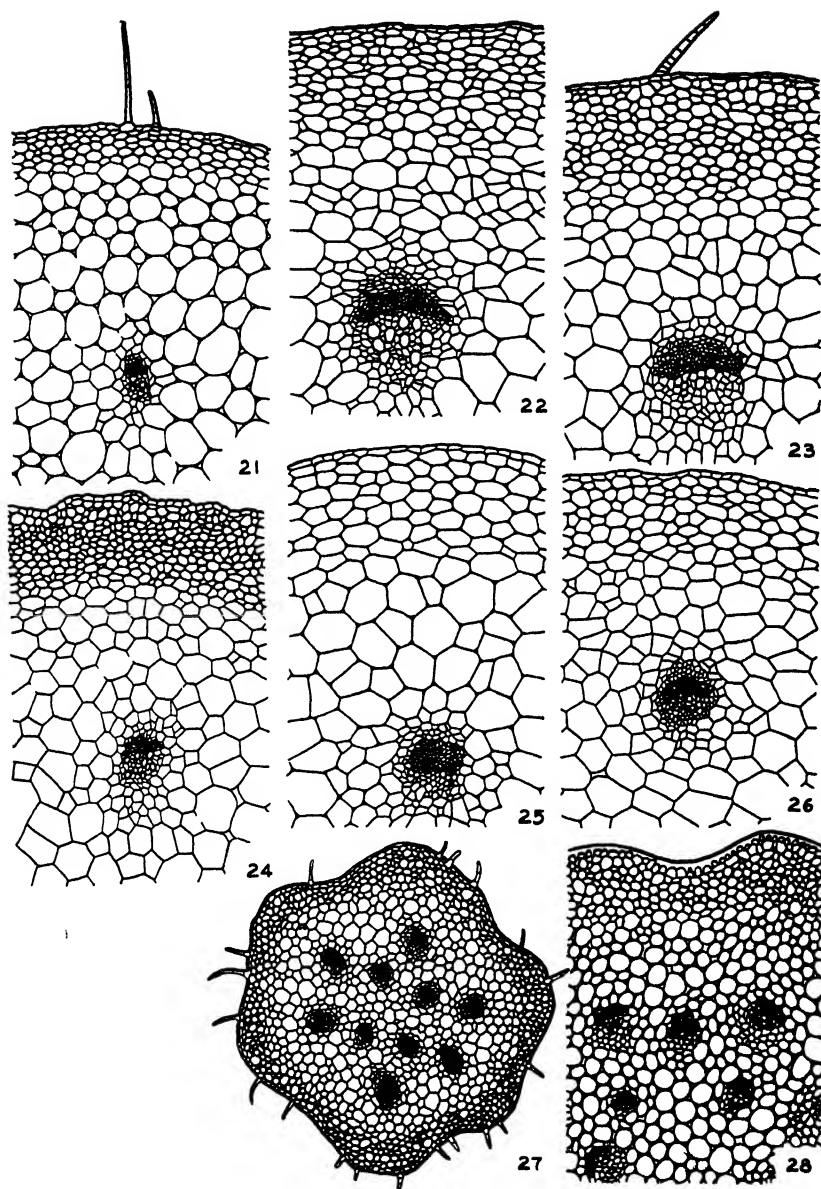
Epidermis. The epidermal cells are, in the main, uniform in shape. *P. sandwicensis* exhibits the largest cells on the average, *P. lilifolia* variety *nudilimba* the smallest. The cuticle is thin for all the species, with the exception of *P. reflexa* and *P. reflexa* variety *parvifolia*, which exhibit a well-defined and comparatively thick cuticle. Stomata were found only on the lower epidermis, excepting in *P. leptostachya*, where a small number were also found in the upper epidermis.

Trichomes. All species except *P. oahuensis* and *P. membranacea* are provided with epidermal hairs. Though resembling the stem hairs in general, many of the leaf hairs, as in *P. expallescens*, are terminally rounded and blunt instead of acute.

Hydathodes. Hydathodes are found on both surfaces of the leaves of all species. They consist of three cells: *a*, a basal cell belonging to the epidermis; *b*, a short stalk cell; and *c*, a hemispherical, spherical, or saclike terminal cell, which in most leaves lies on the same level as the epidermal cells.

Hypoderm. The fleshy part of the leaves of all the species consists of water-storage tissue or "hypoderm" and chlorenchyma tissue. The hypoderm is located just beneath the upper epidermis and is made up of a varying number of layers of large, thin-walled cells, which exhibit great variation in size and have the smallest cells adjacent to the epidermis. Solereder states that according to Pfitzer

The hypoderm in *Peperomia* is developed from a single-layered epidermis. In some cases, viz., when cell division and growth take place equally in the individual layers of the entire integumental tissue, this mode of origin can still be recognized in the mature leaf, the cells of the epidermis and those of the hypodermal layers being arranged in rows at right angles to the surface of the leaf as seen in a transverse section.



FIGURES 21-28.—Details of stems ($\times 38$): 21, *P. leptostachya*; 22, *P. liliifolia* variety *nudilimba*; 23, *P. ellipticibacca*; 24, *P. sandwicensis*; 25, *P. membranacea*; 26, *P. latifolia*; 27, *P. reflexa* variety *parvifolia*; 28, *P. reflexa*.

This arrangement can be seen best in *P. reflexa* variety *parvifolia* (fig. 55) and *P. Cookiana* (fig. 47). In the majority of the species studied, however, the growth and cell division did not take place equally, hence this mode or origin is not so obvious. The thickness of the hypoderm varies from 1 or 2 layers of cells in *P. hirtipetiolata* variety *longilimba* to 9 or 10 layers in *P. reflexa* variety *parvifolia*. Mucilage glands are found in a few species.

Chlorenchyma. The chlorenchyma tissue is of two types: *a*, small, closely packed cells, densely filled with chloroplasts and probably to be considered as a modified palisade tissue; *b*, larger, more loosely arranged cells with fewer chloroplasts. These two layers of tissue are designated in this paper respectively as "dense chlorenchyma" and as "spongy chlorenchyma." The dense chlorenchyma layer lies just beneath the hypoderm and consists of one to three layers of cells. The loose chlorenchyma lies between the dense chlorenchyma and the lower epidermis. In cross section and as observed under low magnification the dense chlorenchyma appears as a dark line separating the hypoderm from the spongy chlorenchyma.

SPECIFIC ANALYSES

Peperomia reflexa (figs. 14, 28, 36, 43, 56).

Stems

The stems are small and fluted and sparingly puberulent with hairs 0.1 to 0.2 mm in length. The epidermal cells, which are heavily cutinized on the radial as well as on the outer surface, range in size from 15 by 20 to 40 by 40 microns. The collenchymatous tissue consists of five to seven layers of cells which range in size from 15 by 20 to 40 by 55 microns. The cells of the ground parenchyma appear circular in cross section and range from 30 to 100 microns in diameter. The intercellular spaces are large and numerous. No crystals were found. The vascular bundles are small and surrounded by small, closely packed parenchyma cells.

Leaves

The leaves are succulent, have little or no mechanical tissue, and are about 1.3 mm thick. The cells of the epidermis show heavy cuticularization and range from 20 by 25 to 30 by 60 microns. The cells of the hypoderm range in size from 30 by 40 to 190 by 230 microns and form 6 to 8 layers of cells or approximately two thirds of the total leaf tissue. The dense chlorenchyma consists of two or three layers of cells, the average size of which is 30 by 40 microns. The cells of the spongy chlorenchyma range from 35 to 105 microns in diameter. Both hydathodes and mucilage glands are present.

***Peperomia reflexa* variety *parvifolia* (figs. 13, 27, 38, 44, 55).**

Stems

The epidermal cells, which are cutinized only on the outer surface, range in size from 10 by 15 to 20 by 30 microns. The epidermal hairs consist of only two or three cells and range from 0.1 to 0.2 mm in length. The cells of the collenchymatous tissue are arranged in only four or five layers and range in size from 10 by 15 to 45 by 50 microns. Though there is considerable difference between the sizes of the stems of this variety and those of *P. reflexa*, the proportion of collenchyma to the rest of the stem is about the same in both. The cells of the ground parenchyma are closely packed and range from 25 to 70 microns in diameter. No crystals were found. The vascular bundles are comparatively small.

Leaves

The epidermal cells, which are not as heavily cuticularized as in *P. reflexa*, range in size from 15 by 30 to 20 by 60 microns. The epidermal hairs consist of two or three cells and range from 0.1 to 0.2 mm in length. The guard cells of the stomata are unique in that they protrude beyond the surface of the leaf. The cells of the hypoderm measure from 30 by 45 to 175 by 300 microns and are arranged in rows at right angles to the leaf surface to form 6 to 10 layers. The hypoderm occupies approximately four fifths of the total leaf tissue. The cells of the dense chlorenchyma average 25 by 35 microns in size and form two or, more rarely, one or three layers. The cells of the spongy chlorenchyma range from 30 to 60 microns in diameter.

***Peperomia oahuensis* (figs. 4, 19, 32, 46, 59).**

Stems

The epidermal cells measure from 10 by 25 to 25 by 45 microns. Hairs are lacking. The collenchymatous tissue occupies 7 to 9 layers of cells, which measure from 15 by 20 to 40 by 55 microns. The ground parenchyma cells measure from 40 to 140 microns in diameter and are polygonal in shape with slightly rounded corners. Large simple crystals are abundant. The vascular bundles are surrounded by several layers of small, thin-walled, closely packed parenchyma cells.

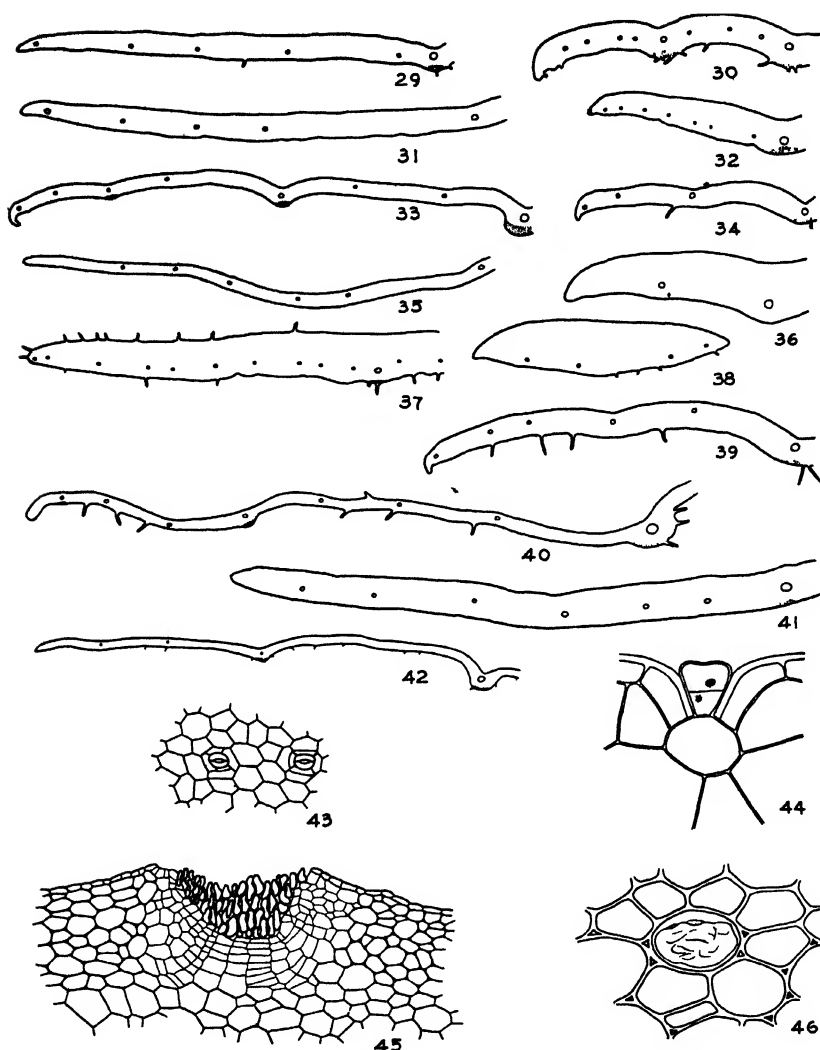
Leaves

The leaves are glabrous and about 0.7 to 0.9 mm thick. Collenchyma is found under the midrib and at the leaf margins. The epidermal cells, which are similar on both surfaces, range in size from 30 by 30 to 40 by 75 microns. The hypoderm is made up of four or five layers of cells which measure from 40 by 40 to 170 by 270 microns and comprises about two thirds of the total leaf tissue. The dense chlorenchyma consists of one or more rarely two layers of cells which average 35 by 45 microns in size. The cells of the spongy chlorenchyma range from 30 to 70 microns in diameter. Hydathodes are abundant, especially on the lower epidermis.

***Peperomia latifolia* (figs. 12, 26, 39, 45, 57).**

Stems

The stems are hirsute above but glabrate below. The sections illustrated are from the lower part of the stem and show no hairs. The hairs, however,



FIGURES 29-46.—Diagrams and details of leaves and stems. 29-42, diagrams of cross sections of leaves: 29, *P. Cookiana* ($\times 6$); 30, *P. ellipticibacca* ($\times 6$); 31, *P. Cookiana* variety *flavinerva* ($\times 6$); 32, *P. oahuensis* ($\times 6$); 33, *P. lilifolia* variety *nudilimba* ($\times 6$); 34, *P. expallescens* ($\times 6$); 35, *P. membranacea* ($\times 6$); 36, *P. reflexa* ($\times 6$); 37, *P. leptostachya* ($\times 6$); 38, *P. reflexa* variety *parvifolia* ($\times 6$); 39, *P. latifolia* ($\times 6$); 40, *P. hirtipetiolata* variety *longilimba* ($\times 6$); 41, *P. sandwicensis* ($\times 6$); 42, *P. Rockii* ($\times 2.5$). 43-46, details of leaves and stems: 43, *P. reflexa*, detail of lower epidermis ($\times 71$); 44, *P. reflexa* variety *parvifolia*, detail of hydathode ($\times 275$); 45, *P. latifolia*, detail of lenticel ($\times 38$); 46, *P. oahuensis*, detail of mucilage canal ($\times 170$).

range from 0.35 to 0.75 mm in length. The epidermal cells measure 20 by 35 up to 30 by 60 microns. The collenchymatous tissue consists of six or seven layers of cells which measure from 25 by 30 to 65 by 100 microns. Lenticels which do not protrude above the surface of the epidermis are common in this species. The ring of collenchyma is broken in the region of the lenticel, which would make it appear that the phellogen was formed in the outer part of the ground parenchyma or from the innermost layer of collenchyma. The cells of the ground parenchyma range from 50 to 230 microns in diameter. A comparatively small number of simple crystals were found.

Leaves

The leaves average from 0.5 to 0.6 mm in thickness. Only a small amount of collenchyma was found in the region below the midrib. The cells of both the lower and the upper epidermis are similar and measure from 20 by 30 to 40 by 60 microns. The epidermal hairs are mostly restricted to the lower surface, are sharp-pointed, consist of 13 to 16 cells, and range in length from 0.35 to 0.7 mm. Approximately one half of the leaf tissue is hypoderm which is made up of two or three layers of cells ranging from 30 by 40 to 130 by 160 microns in size. The cells of the spongy parenchyma range from 40 to 100 microns in diameter. The dense chlorenchyma consists of two to three layers of cells averaging about 35 by 50 microns. Hydathodes are abundant, and mucilage glands are found in the hypoderm.

***Peperomia membranacea* (figs. 10, 25, 35, 53).**

Stems

The stems of this species are glabrous. The epidermal cells range from 15 by 40 to 30 by 80 microns. The collenchymatous layer consists of five or six layers of cells measuring 30 by 50 to 90 by 110 microns. The ground parenchyma cells are polygonal in shape and measure from 60 to 240 microns in diameter. Numerous large crystals of both the simple and the druse types were observed. A few of the crystals are located in the innermost cells of the collenchymatous layer. The vascular bundles are surrounded by small, closely packed parenchyma cells.

Leaves

The leaves are comparatively thin, entirely glabrous, and show no evidence of mechanical tissue. The cells of the upper epidermis measure from 20 by 40 to 50 by 90 microns; those of the lower epidermis are slightly larger. The hypoderm consists of one layer or, more rarely, two layers of cells which measure about 80 by 125 microns. The dense chlorenchyma consists of one or rarely two layers of cells which average about 25 by 40 microns. The spongy chlorenchyma is composed of cells commonly more or less horizontally elongated and measuring from 25 by 25 to 60 by 120 microns. Hydathodes are present; their upper cells and also their stalk cells may project above the level of the epidermis.

***Peperomia ellipticibacca* (figs. 6, 23, 30, 49).**

Stems

The stems are densely hirsute with slender, rusty-brown hairs ranging from 0.4 to 1 mm in length. The epidermal cells range from 15 by 25 to 25

by 60 microns. The collenchyma cells measure from 25 by 35 to 100 by 100 microns and form as many as 12 or 15 layers. The cells of the ground parenchyma vary considerably in size, ranging from 60 to 280 microns in diameter. Small intercellular spaces are numerous. The crystals are scattered throughout the ground parenchyma and are predominatingly of the simple type. The vascular bundles are surrounded by small, closely packed parenchyma cells.

Leaves

The leaves are approximately 0.7 mm thick. Small amounts of collenchyma tissue are found just beneath the midrib and each of the larger veins. The cells of the upper epidermis measure 15 by 35 to 50 by 75 microns; those of the lower epidermis are slightly smaller. The epidermal hairs are stout, blunt-tipped, measure from 0.4 to 0.9 mm in length, and are confined largely to the lower epidermis. The leaf tissue is almost equally divided between the chlorenchyma and the hypoderm, which consists of three or four layers of cells which measure from 20 by 40 to 150 by 250 microns. The dense chlorenchyma tissue consists of two or three layers of elongated cells about 30 by 45 microns in size. The cells of the spongy parenchyma measure from 30 to 70 microns in diameter. Hydathodes are present but not numerous.

Peperomia Cookiana (figs. 1, 16, 29, 47).

Stems

The stems are densely hirsute. The hairs are slender, composed of as many as eight cells, and range in length from 0.6 to 1.3 mm. The epidermal cells are more or less uniform in shape and size and measure about 20 by 50 microns. The cells of the ground parenchyma range from 40 to 250 microns in diameter. Crystals of the druse type are abundant. The vascular bundles are surrounded by small parenchymatous cells.

Leaves

The leaves are about 0.5 mm thick, with a small amount of collenchyma tissue below the midrib. The cells of both the lower and upper epidermis are similar and measure from 20 by 40 to 50 by 90 microns. The epidermal hairs are stoutish and range from 0.6 to 1.5 mm long. The hypoderm is composed of three or four layers of cells, which range in size from 25 by 80 to 160 by 200 microns and which make up approximately three fifths of the total leaf tissue. The dense chlorenchyma consists of two rows of slightly elongated, closely packed cells which average 40 by 50 microns. The loose parenchyma cells vary from 30 to 70 microns in diameter. Hydathodes are numerous.

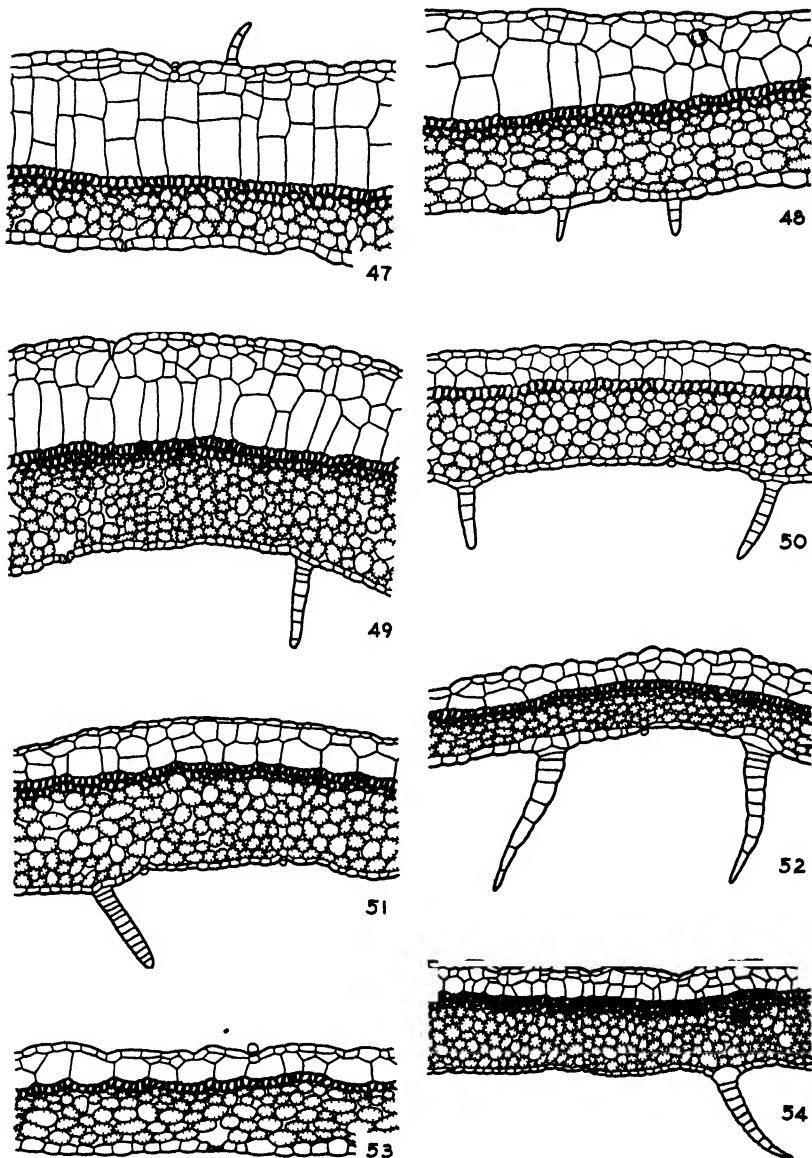
Peperomia Cookiana variety **flavinerva** (figs. 2, 15, 31, 48).

Stems

The stems are hirsute with hairs similar in structure and size to those of *P. Cookiana*. The epidermal cells range in size from 15 by 40 to 20 by 60 microns. The collenchyma is made up of six to eight layers, the cells of which measure 20 by 30 to 40 by 80 microns. In other respects these stems are similar to those of *P. Cookiana*.

Leaves

The leaves average approximately 0.5 mm in thickness and show no mechanical tissue. The epidermal hairs are similar in size and shape to those



FIGURES 47-54.—Details of cross sections of leaves ($\times 38$): 47, *P. Cookiana*; 48, *P. Cookiana* variety *flavinerva*; 49, *P. ellipticibacca*; 50, *P. Rockii*; 51, *P. expallescens*; 52, *P. hirtipetiolata* variety *longilimba*; 53, *P. membranacea*; 54, *P. lilifolia* variety *nudilimba*.

of *P. Cookiana*. The upper epidermis is similar to the lower epidermis, the cells of which measure 15 by 40 to 20 by 60 microns. The hypoderm consists of two or three layers, the cells of which measure from 50 by 60 to 200 by 270 microns, and it makes up approximately half of the entire leaf tissue. The dense chlorenchyma tissue commonly consists of two or, more rarely, three layers of cells which average about 30 by 40 microns. The spongy parenchyma cells range from 40 to 100 microns in diameter. Hydathodes are numerous on both the upper and lower surfaces. Mucilage glands are present but are confined to that region of the hypoderm just beneath the upper epidermis.

***Peperomia leptostachya* (figs. 8, 21, 37, 58).**

Stems

The stems are densely pubescent, with thin, delicate hairs consisting of three or four elongated cells and ranging in length from 0.1 to 0.55 mm. The epidermal cells measure from 10 by 30 to 20 by 40 microns. The collenchymatous tissue consists of four or five layers, the cells of which are but slightly larger than the epidermal cells and measure from 15 by 20 to 35 by 60 microns. The cells of the ground parenchyma appear circular, have large intercellular spaces, and measure from 25 to 90 microns in diameter. No crystals were observed.

Leaves

The leaves of this species are mostly 0.8 to 0.9 mm thick. There is no mechanical tissue except a small amount of collenchyma in the region of the midrib. The leaves are pubescent on both surfaces, with hairs composed of 3 to 7 cells and measuring from 0.07 to 0.4 mm in length. The epidermal cells measure from 20 by 35 to 40 by 70 microns. A small number of stomata were observed in the upper epidermis in addition to those commonly found in the lower epidermis. The hypoderm, which is composed of four layers of cells ranging in size from 20 by 35 to 170 by 360 microns, occupies approximately two thirds of the total leaf tissue. The cells of the dense chlorenchyma, which average about 35 by 50 microns, occupy two or three layers. The cells of the spongy chlorenchyma are but slightly larger, measuring from 40 to 70 microns in diameter.

***Peperomia sandwicensis* (figs. 9, 24, 41, 60).**

Stems

The stems are hirsute above but glabrate below. The hairs range from 0.3 to 0.75 mm in length. The epidermal cells range from 15 by 20 to 25 by 40 microns. The collenchyma is made up of 10 to 14 layers of cells which range from 20 by 20 to 35 by 50 microns. The cells of the ground parenchyma are moderately closely packed, are polygonal in outline, and range from 30 to 60 microns in diameter. The crystals are of the druse type and comparatively few. The vascular bundles are small and surrounded by small, closely packed parenchyma cells.

Leaves

The leaves are without any mechanical tissue except a small amount of collenchyma beneath the midrib. The epidermal cells are similar in shape and size in both the upper and lower epidermis and measure from 30 by 45 to 50 by 85 microns. The hairs are multicellular and blunt-tipped and range from

0.3 to 0.7 mm long. The hypoderm, which occupies one half to three fifths of the total leaf tissue, is composed of 3 to 5 layers of cells ranging in size from 70 by 90 to 245 by 300 microns. The dense chlorenchyma tissue is generally composed of two or, more rarely, one or three layers of cells, which are about 35 by 40 microns. The cells of the spongy chlorenchyma range from 30 to 80 microns in diameter. Hydathodes are not abundant.

***Peperomia lilifolia* variety *nudilimba* (figs. 11, 22, 33, 54).**

Stems

The stems are essentially glabrous. The epidermal cells measure from 10 by 20 to 20 by 50 microns and have a definite cuticle. The collenchymatous tissue consists of 10 or 12 layers of cells which range from 20 by 30 to 60 by 90 microns. The vascular bundles are numerous and comparatively large. The cells of the ground parenchyma range from 60 to 480 microns in diameter. The crystals, which are scattered throughout, are mostly of the druse type with a few scattered simple crystals.

Leaves

The leaves are about 0.4 mm thick. Collenchyma is found beneath the midrib and each of the larger veins. The epidermal cells are similar on both surfaces and measure from 10 by 20 to 25 by 60 microns. The hairs, which resemble those of *P. hirtipetiolata* variety *longilimba* in shape and cell arrangement, range from 0.4 to 1 mm. in length. The hypoderm, which makes up about one third of the total leaf tissue, consists of two layers of cells which measure from 15 by 20 to 70 by 80 microns. The cells of the dense chlorenchyma are arranged in two or three layers and average 25 by 30 microns. The spongy chlorenchyma is comparatively compact and is composed of cells ranging from 20 to 65 microns in diameter. Hydathodes are not abundant.

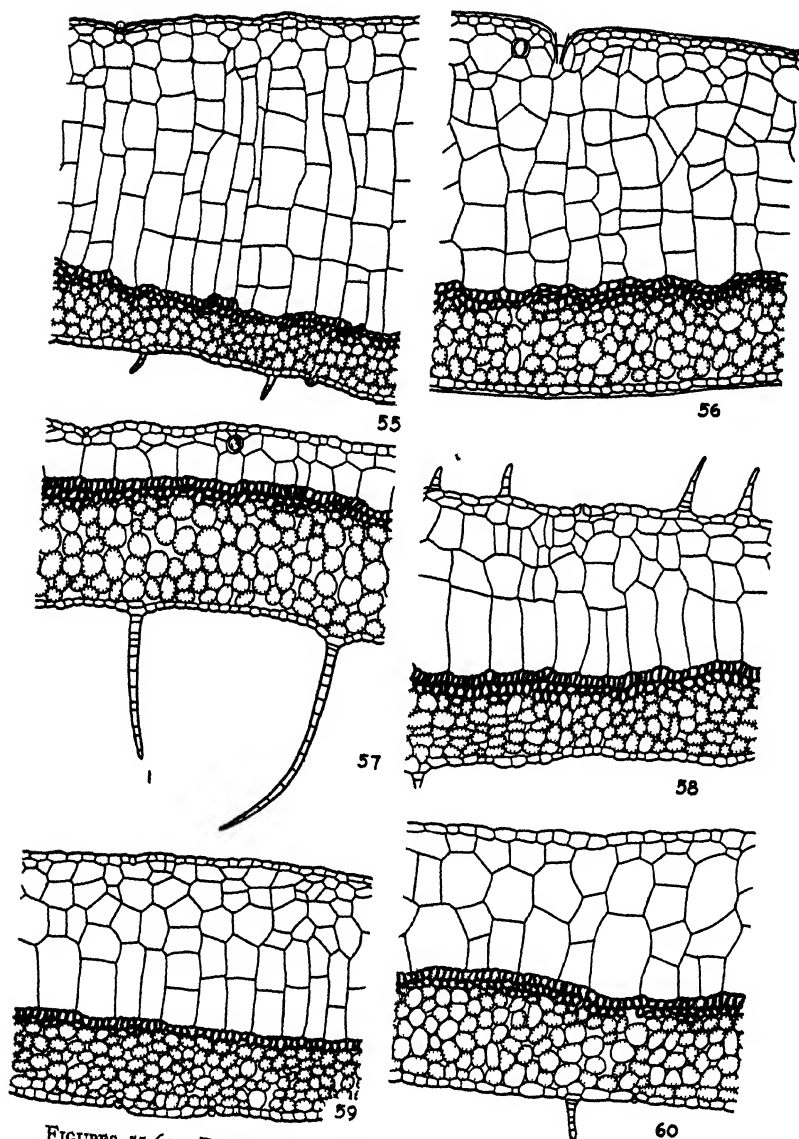
***Peperomia Rockii* (figs. 7, 18, 42, 50).**

Stems

The hairs range in size from 0.3 to 0.7 mm in length but are mostly about 0.5 mm. The epidermal cells range in size from 15 by 20 to 20 by 50 microns. The collenchymatous tissue consists of 22 or 23 layers of cells which appear almost round in cross section and range in size from 10 by 15 to 50 by 60 microns. The cells of the ground parenchyma are closely packed and range from 40 to 120 microns in diameter. No crystals were observed. The vascular bundles are comparatively large.

Leaves

Collenchymatous tissue is present beneath the midrib and larger veins. The cells of both the upper and lower epidermis are similar in shape and size and range from 20 by 30 to 35 by 80 microns. The epidermal hairs range from 0.23 to 0.55 mm in length. The cells of the hypoderm measure from 30 by 45 to 80 by 110 microns and form two layers which occupy one fourth to one third of the total leaf tissue. The dense chlorenchyma consists of only one layer of cells, the average size of which is 35 by 40 microns. The cells of the spongy chlorenchyma range from 40 to 80 microns in diameter. Hydathodes are not abundant.



FIGURES 55-60.—Details of cross sections of leaves ($\times 38$); 55, *P. reflexa* variety *parvifolia*; 56, *P. reflexa*; 57, *P. latifolia*; 58, *P. leptostachya*; 59, *P. sandwicensis*; 60, *P. sandwicensis*.

***Peperomia hirtipetiola* variety *longilimba* (figs. 3, 17, 40, 52).**

Stems

The stems are very densely hirsute, with hairs mostly 1 to 2 mm long and made up of 25 to 35 thick-walled cells. The epidermal cells range in size from 15 by 30 to 25 by 50 microns. The cells of the collenchyma, which may form as many as 15 layers, range in size from 30 by 35 to 60 by 100 microns. The cells of the ground parenchyma are closely packed, have small intercellular spaces, and range from 40 to 300 microns in diameter. No crystals were found. The vascular bundles are comparatively large.

Leaves

The leaves are comparatively thin, averaging about 0.3 mm. Collenchymatous tissue is present beneath the midrib and the larger veins. The epidermal cells range from 20 by 35 to 50 by 95 microns. The epidermal hairs are elongated, cone-shaped, multicellular, and range from 0.25 to 1.5 mm in length. The lower cells of the hairs are flat and disc-shaped; those toward the outer end are more elongated. The hypoderm, which makes up about two fifths of the total leaf tissue, is composed of one or two layers of cells that range in size from 35 by 40 to 90 by 140 microns. The cells of the dense chlorenchyma are about 30 by 40 microns and form two layers. The cells of the spongy chlorenchyma range from 25 to 50 microns in diameter. The hydathodes are slightly raised above the level of the epidermis.

***Peperomia expallescens* (figs. 5, 20, 34, 51).**

Stems

The stems are densely hirsute above but glabrate below. The hairs range from 0.7 to 1.4 mm in length. The epidermal cells are comparatively small, ranging from 10 by 30 to 20 by 65 microns. The collenchyma is made up of 10 or 11 layers of comparatively small cells which range from 10 by 20 to 40 by 70 microns. The ground parenchyma consists of medium-sized cells measuring from 50 to 175 microns in diameter and having few intercellular spaces. A small number of simple crystals were found.

Leaves

The leaves are 0.5 to 0.6 mm thick. A small amount of collenchyma is present beneath the midrib. The cells of the upper and lower epidermises are similar in shape and size, ranging from 10 by 30 to 20 by 65 microns. The epidermal hairs—stout, very blunt-tipped, composed of flat, disclike cells—range in length from 0.4 to 1.0 mm and are most abundant on the lower surface. The hypoderm is composed of cells from 40 by 50 to 105 by 140 microns in size and form two or three layers making up about one third of the total leaf tissue. The dense chlorenchyma tissue consists of two or, more rarely, three layers of cells which average about 30 by 40 microns. The cells of the spongy chlorenchyma range from 40 to 70 microns in diameter. Hydathodes are numerous.

REVISED LIST OF HAWAIIAN ANTS

By

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INTRODUCTION

The foundations of our knowledge of the Formicidae of Hawaii were laid by Forel in a short paper published in 1899 in the "Fauna Hawaiiensis". He enumerated 20 forms, but three of these do not belong to the Hawaiian fauna, namely, *Aphaenogaster* (*Nystalomyrma*) *longiceps* F. Smith, a well-known Australian ant, recorded from Honolulu (Rothney) but not since taken in the islands; *Pogonomyrmex occidentalis* Cresson, a harvesting ant of the Rocky Mountains which must have borne an erroneous locality label in Forel's collection; and *Paratrechina* (*Nylanderia*) *obscura* Mayr, an Australian species cited by Blackburn and Cameron from the Hawaiian islands but probably the form later described by Forel as *P. (N.) bourbonica hawaiiensis*.

In 1913 Gulick published a useful synopsis and list of the Hawaiian ants, comprising 23 forms. As the three above mentioned were omitted, only 6 forms had been added during the 14 years since the publication of Forel's paper.

A visit to the islands during April and May, 1930, enabled me to acquire some acquaintance with the ants of the islands of Oahu and Hawaii and with the valuable collections in Bernice P. Bishop Museum, the Sugar Planters' Experiment Station, and the Federal Quarantine Station in Honolulu. Mr. E. H. Bryan of the Museum, Mr. O. H. Swezey of the Experiment Station, and Mr. E. M. Ehrhorn of the Quarantine Station gave me every assistance in studying the collections and in finding the pertinent literature. Mr. Swezey, who accompanied me on a visit to the island of Hawaii, placed at my disposal his amazing knowledge of the insects and plants of the archipelago, and Drs. F. X. Williams, H. R. Hagan and J. F. Illingworth, and Mr. C. E. Pemberton conducted me to interesting collecting grounds on Oahu. I am also indebted to Mr. R. H. Van Zwaluwenburg and Dr. Williams for interesting series of hypogaecic ants collected on the same island.

The revised list here presented as the result of all this generous assistance and my own more limited field observations comprises

35 forms and therefore shows an accession of only 12 items during the past 20 years. The area covered, however, is greater than that of previous lists, since it includes also the small windward islands, but these have yielded only two forms not recorded from the larger more southerly islands, *Ponera punctatissima schauinslandi* Emery and *Monomorium minutum* Mayr. The records of *M. minutum* may refer to the variety *liliuokalanii* Forel.

Thirty-five species, subspecies, and varieties are a meager ant fauna for an area as large as Hawaii, possessing a tropical climate, an abundance of other insects, and a magnificent indigenous and introduced flora. It is, indeed, quite as meager as and not unlike the ant faunas of Society Islands and Marquesan Islands. Nevertheless, the present list is of considerable interest, for, owing to the perseverance and acumen of the entomologists in Honolulu, it is undoubtedly more nearly complete than the ant list of any other group of islands in the Pacific. It is probable, therefore, that any further accessions will be exclusively or almost exclusively recent introductions by man.

The zoögeographical consideration of the Hawaiian ants may be facilitated by dividing them into the three following groups:

ENDEMIC SPECIES

Cerapachys (*Syscia*) *silvestrii* Wheeler
Ponera *kalakauae* Forel
Ponera *perkinsi* Forel
Pseudocryptopone *zwaluwenburgi* Wheeler
Pseudocryptopone *swezeyi* Wheeler
Epitritus *wheeleri* Donisthorpe

ENDEMIC SUBSPECIES AND VARIETIES

Ponera *gleadowi* *decepiens* Forel
Ponera *punctatissima* *schauinslandi* Emery
Leptogenys *falcigera* *insularis* F. Smith
Monomorium *minutum* Mayr variety *liliuokalanii* Forel
Cardiocondyla *nuda* Mayr variety *minutior* Forel
Cardiocondyla *wroughtoni* Forel variety *hawaiiensis* Forel
Strumigenys (*Cephaloxys*) *membranifera* Emery variety *williamsi* Wheeler
Camponotus (*Tanaemyrmex*) *variegatus* *hawaiiensis* Forel
Paratrechina (*Nylanderia*) *bourbonica* *hawaiiensis* Forel

PANTROPICAL VAGRANTS

**Pheidole* *megacephala* Fabricius
 **Solenopsis* *geminata* *rufa* Jerdon
 **Monomorium* *floricola* Jerdon

Monomorium fossulatum seychellense Emery
Monomorium latinode Mayr
Monomorium minutum Mayr
 **Monomorium pharaonis* Linnaeus
 **Monomorium* (*Parholcomyrrex*) *destructor* Jerdon
 **Monomorium* (*Parholcomyrrex*) *gracillimum* F. Smith
 **Tetramorium guineense* Fabricius
 **Tetramorium simillimum* F. Smith
Tetramorium tonganum Mayr
Strumigenys lewisi Cameron
 **Tapinoma melanocephalum* Fabricius
 **Technomyrmex albipes* F. Smith
Plagiolepis exigua Forel
Plagiolepis mactavishi Wheeler
Brachymyrmex heeri Forel variety *aphidicola* Forel
 **Paratrechina longicornis* Latreille
Paratrechina (*Nylanderia*) *sharpi* Forel

The following inferences may be drawn from an inspection of these lists:

1. The six endemic species are all diminutive, blind or myopic, subterranean ants, that is, members of the interesting biocoenose which Silvestri has called the "microgenton". Furthermore, they all belong to the archaic subfamily Ponerinae, with the exception of *Epitritus wheeleri*, which is itself a member of an ancient cosmopolitan Myrmicine genus with very discontinuous distribution. These few ants may therefore be regarded as so many relics of the original, early Tertiary fauna of the archipelago and as probably owing their survival, in what must have been at times and over considerable areas a very unfavorable volcanic environment, to their exquisite hypogaeic habits. All 6 species are essentially Old World forms and 3 of them, the *Cerapachys* and the 2 species of *Pseudocryptopone*, are closely related to East Indian and Papuan species.

2. With the exception of *Leptogenys insularis* and *Camponotus hawaiiensis*, the 9 forms in the second list are of small stature and 4 of them, *Ponera decipiens* and *P. schauinslandi*, *Strumigenys williamsi*, and *Monomorium seychellense* are members of the microgenton. All are subspecies or varieties of Old World species and 5, *Ponera gleadowi*, *Cardiocondyla nuda* and *C. wroughtoni*, *Camponotus hawaiiensis*, and *Paratrechina bourbonica*, are clearly of Indo-Malayan origin. *Strumigenys membranifera* variety *williamsi*, as I have shown (1933), has a very peculiar distribution, since the typical form was described from Italy, and its 4 subspecies and

varieties occur in Tunis, St. Thomas Island, West Indies, the Gulf States of North America, and Hawaii, respectively. We may regard the forms in the second list as ancient immigrants whose relatively long sojourn in the islands is attested by their development of perceptible subspecific or varietal characters.

3. The third series of 20 forms, or 57 per cent of the whole Hawaiian ant fauna, comprises pantropical waifs, or vagrants, which may be subdivided into two groups. Eleven, indicated by asterisks, are already widely distributed throughout the warmer portions of both hemispheres, whereas the others seem to be invading the same regions at a slower or more hesitant pace. All these ants belong to the Indo-Malayan or Indonesian fauna with the single exception of *Brachymyrmex hecvi* variety *aphidicola*, which is of neotropical origin and has only recently established itself in fernhouses in Honolulu. It might be omitted from the list, until it has demonstrated its ability to survive in the open country.

Honolulu, since its development as a port and naval base, has become the focus of introduction of many insects. The number of species of ants introduced with merchandise and lumber from Oriental and American ports, often as whole colonies, is remarkable. I give below a list compiled from the specimens and records of species which Mr. Ehrhorn and his assistants have succeeded in intercepting at the Quarantine Station within recent years. The countries cited as the direct source of some of the forms may not be accurate, because tropical ants not infrequently establish their colonies in the woodwork of vessels and later move into the transported lumber or merchandise.

Ants Intercepted at the Quarantine Station, Honolulu



PONERINAE

† <i>Holcoponera porcata</i> Emery.....	Costa Rica
<i>Euponera</i> (<i>Brachyponera</i>) <i>luteipes</i> Mayr.....	China, Manila
<i>Euponera</i> (<i>Brachyponera</i>) <i>solitaria</i> F. Smith.....	Japan
* <i>Odontomachus haematoda</i> Linnaeus.....	Panama, Trinidad, Manila

MYRMICINAE

† <i>Pheidole hyatti</i> Emery.....	California
<i>Pheidole javana</i> Mayr.....	China, India, Manila
* <i>Pheidole megacephala</i> Fabricius.....	Japan, China
† <i>Pheidole punctatissima</i> Mayr.....	Central America
<i>Pheidole rhombinoda</i> F. Smith.....	China

* <i>Solenopsis geminata rufa</i> Jerdon	Java, China
<i>Pheidologeton affinis</i> F Smith 2♂ ♀	China
* <i>Monomorium floricola</i> Jerdon	Manila, in orchids
* <i>Monomorium pharaonis</i> Linnaeus	Japan, China, Manila, Ceylon,
India, San Francisco, California, Brisbane, Australia	
* <i>Monomorium</i> (<i>Parholcomymex</i>) <i>destructor</i> F Smith	Japan
* <i>Monomorium</i> (<i>Parholcomymex</i>) <i>gracillimum</i> F Smith	China
<i>Crematogaster</i> (<i>Acrocoelia</i>) <i>laboriosa</i> F Smith	Japan
† <i>Crematogaster</i> (<i>Acrocoelia</i>) <i>lineolata californica</i> Emery	California
<i>Tetramorium caespitum</i> Linnaeus variety	Japan
* <i>Tetramorium guineense</i> Fabricius	China, Guam
<i>Tetramorium pacificum</i> Mayr	Manila
* <i>Tetramorium simillimum</i> F Smith	Japan, Manila
<i>Triglyphothrix striatidens</i> Emery	Manila
† <i>Wasmannia auropunctata</i> Roger	Central America
* <i>Strumigenys lewisii</i> Cameron	Japan
† <i>Cyphomyrmex rimosus</i> Spinola	Panama, Trinidad

DOLICHODERINAE

<i>Dolichoderus</i> (<i>Hypoclinea</i>) <i>bituberculatus</i> Mayr	Manila
<i>Dolichoderus</i> (<i>Hypoclinea</i>) <i>quadripunctatus</i> Linnaeus variety	Japan
† <i>Iridomyrmex humilis</i> Mayr	California
<i>Iridomyrmex itoi</i> Forel	Japan
* <i>Technomyrmex albipes</i> F Smith	Manila
* <i>Tapinoma melanocephalum</i> Fabricius	Manila

FORMICINAE

<i>Plagiolepis melanogaster</i> Emery	Manila, in orchids
<i>Lasius niger</i> Linnaeus	Japan, China
<i>Lasius niger alienus</i> Forster	Japan
† <i>Lasius niger alienus</i> variety <i>americanus</i> Emery	California
<i>Lasius</i> (<i>Chthonolasius</i>) <i>flavus</i> De Geer	Germany
† <i>Formica subpolita</i> Mayr	Washington
<i>Camponotus obscuripes</i> Mayr	Japan
<i>Camponotus</i> (<i>Tanaemyrmex</i>) <i>nicobarensis exiguo-guttatus</i> Emery	China
† <i>Camponotus</i> (<i>Myrmothrix</i>) <i>abdominalis</i> Fabricius	Trinidad
<i>Camponotus</i> (<i>Myrmentoma</i>) <i>itoi</i> Forel	Japan
† <i>Camponotus</i> (<i>Myrmobranchys</i>) <i>planatus</i> Roger	Central America
<i>Polyrhachis</i> (<i>Myrmhopla</i>) <i>argentea</i> Mayr	Manila
* <i>Paratrechina longicornis</i> Latreille	China, Japan, Borneo, Manila
<i>Paratrechina</i> (<i>Nylanderia</i>) <i>bourbonica</i> Forel	Hongkong
† <i>Paratrechina</i> (<i>Nylanderia</i>) <i>parva</i> Mayr	New Jersey

Of the 46 forms on this list, 12 (26.3%) are neotropical or nearctic (indicated by daggers) and 34 (73.7%) are paleotropical or palearctic. Among the latter are 13 well-known tropical vagrants (indicated by asterisks), 10 of which, as we have seen, had been previously introduced and had become established in the Hawaiian islands. It is difficult to explain the absence of one species, *Anoplo-*

lepis longipes, from all the preceding lists, because it is abundant and widely distributed not only in Indo-Malaya and Indonesia but also throughout Polynesia as far east as Samoa and Fiji, and has even established itself in one locality in western Mexico. It is almost as difficult to account for the fact that *Tetramorium pacificum* Mayr, which has much the same distribution and is on the list of species intercepted at the Quarantine Station, has not succeeded in establishing itself in Hawaii. Among the intercepted species we find also the Argentine ant, *Iridomyrmex humilis*, an originally neotropical species and the most pernicious of those recorded. Should it eventually secure a foothold in the islands, we may look forward to a repetition of what has occurred in Madeira and the Canary Islands, where it has not only exterminated *Phcidole megacephala*, but has also practically wiped out the indigenous ant fauna at elevations below 3,000 feet, just as *P. megacephala* is at present, according to Illingworth, actively displacing *Solenopsis rufa* on the island of Oahu.

The ant fauna, though meager, exhibits certain interesting peculiarities comparable in some respects with those of other faunal groups in the Hawaiian islands. These peculiarities may be briefly summarized:

1. Endemicity among the ants is rather high, though not so striking as among some other groups of insects, and the mollusks, birds, and plants. There are no endemic genera of Formicidae, but the family is represented, nevertheless, by 6 species and 9 subspecies and varieties peculiar to the islands (42.85 per cent of the whole ant fauna).

2. With the exception of the recently introduced *Brachymyrmex aphidicola*, all the forms are clearly of East Indian, Polynesian, or palearctic origin or affinities. Twenty of them (57.14 per cent) are, in fact, widely distributed forms in these regions.

3. No affinities with precinctive neotropical or nearctic forms are discernible, except in the previously mentioned *Brachymyrmex*.

4. Although very close relations have been detected between certain Hawaiian and Australian plants by Campbell (1933) and others, I am unable to find any such connections among the Formicidae. The two Hawaiian species of *Pseudocryptopone* are, however, more closely related to the Papuan than to the East Indian species. This is notably true of *P. swezeyi*, which is very closely allied to *P. tenuis* Emery and *P. mocsaryi* Szabó of New Guinea.

5. Though many of the Hawaiian ants are widely distributed over the archipelago, they have not been found to exhibit any local subspecies or varieties on the different islands like those observed in some of the ants of the Galapagos Islands (Wheeler 1920, 1924). Guppy's contention (1906) that the Hawaiian islands first appeared above the ocean in early Tertiary times and acquired their fauna and flora in the same manner as Krakatao after the eruption of 1883, is of some interest in this connection. Had the islands arisen by subsidence as so many remnants of a greater land mass already peopled by ants, we should expect a development of local subspecies or varieties of at least a few of the species on each island. But the force of this inference is weakened by two considerations: first, the time which has elapsed since the formation of the separate islands may not have been sufficiently long to produce differences of subspecific or even varietal magnitude, and second, more extensive collecting and very searching comparison of the collected material may yet show that certain species at least are actually represented by constant, though very feebly differentiated, local forms on some of the islands.

FAMILY FORMICIDAE

SUBFAMILY CERAPACHYINAE

1. *Cerapachys (Syscia) silvestrii* Wheeler.

Cerapachys (Syscia) silvestrii Wheeler: Lab. Zool. Gen. Agrar. Portici, Boll., vol. 3, p. 269, 1909, ♀. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 306, appendix, 1913; Swezey, vol. 3, p. 281, 1917; Ehrhorn, vol. 3, p. 284, 1917.

Hawaii: Hilo, type locality (Silvestri). Oahu (Van Zwaluwenburg): Honolulu (Ehrhorn); nesting in compost heap (Swezey).

SUBFAMILY PONERINAE

2. *Ponera gleadowi decipiens* Forel.

Ponera decipiens Forel: Fauna Hawaiiensis, vol. 1, p. 118, 1899, ♀. Gulick: Haw. Ent. Soc., Proc., vol. 2, p. 306, appendix, 1913.

Kauai: on the coast, type locality. Oahu: Haw. Sugar Plant. Assoc., Exp. Sta., in compost (Swezey).

3. *Ponera kalakauae* Forel.

Ponera kalakauae Forel: Fauna Hawaiiensis, vol. 1, p. 116, 1899, ♂ ♀. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 306, 310, 1913; Bridwell, vol. 3, p. 24, 1914. Timberlake: B. P. Bishop Mus., Bull. 31, p. 17, 1926.

Kauai: Lihue (type locality). Oahu (Van Zwaluwenburg): Honolulu (Bryan); Moanalua; Palolo; Tantalus; Waianae (Illingworth); Hauula; Kolekole Pass. Hawaii: Hilo Sugar Company (Swezey). Maui: Hana (Bryan). Molokai (Illingworth).

French Frigates Shoal (Bryan) ♀. Necker Island, ♂. Laysan Island (Fullaway) ♀.

4. *Ponera perkinsi* Forel.

Ponera perkinsi Forel: Fauna Hawaiiensis, vol. 1, p. 117, 1899, ♂ ♀ ♂. Wheeler: Lab. Zool. Gen. Agrar. Portici, Boll., vol. 3, p. 271, 1909, ergato-morphic ♂. Haw. Ent. Soc., Proc.: Gulick, vol. 2, pp. 306, 310, 1913, appendix; Perkins, vol. 1, p. 43, 1906; Illingworth, vol. 5, p. 273, 1923; Swezey and Bryan, vol. 7, p. 296, 1929.

Oahu: Tantalus, Lanihuli (Swezey, Bryan); Honolulu (Bridwell, Illingworth); Kuliouou, Palolo Valley, Kaumuahona, Kaimuki, Niu (Swezey); Nuuanu Pali (Ehrhorn). Molokai: forests (Swezey and Bryan). Maui: Haleakala (Swezey). Kauai: Summit Camp (Swezey); Koloa. Hawaii: Waimea.

"In the mountains on all the islands, generally from 2,000 to 4,000 feet" (Perkins).

5. *Ponera punctatissima schauinslandi* Emery.

Ponera punctatissima schauinslandi Emery: Zool. Jahrb., Syst., vol. 12, p. 439, 1899, ♀.

Laysan Island: type locality (Schauinsland).

6. *Pseudocryptopone zwaluwenburgi* Wheeler.

Pseudocryptopone zwaluwenburgi Wheeler: Am. Mus., Novitates, no. 672, p. 14, fig. 5, 1933, ♀.

Oahu: Honolulu (type locality); Waimanalo, Waialua, Waipio (Van Zwaluwenburg), in soil of sugar cane fields, both fallow and under cultivation. Maui: central portion, in field of growing sugar cane (Van Zwaluwenburg).

Pseudocryptopone swezeyi Wheeler.

Pseudocryptopone swezeyi Wheeler: Am. Mus., Novitates, no. 672, p. 16, fig. 6, 1933, ♂ ♀.

Oahu: Honolulu (type locality), in soil of sugar cane fields, both fallow and under cultivation (Van Zwaluwenburg).

8. *Leptogenys falcigera insularis* F. Smith.

Leptogenys insularis F. Smith: Linn. Soc. London, Zool., Jour., vol. 14, p. 675, 1879, ♀. Forel: Fauna Hawaiiensis, vol. 1, p. 118, 1899, ♀. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 306, 1913, appendix; Bryan, vol. 7, p. 226, 1929; Swezey and Bryan, vol. 7, p. 296, 1929.

Kauai: Puu Konanae, altitude 300 feet, above Anahola River (Bryan); Lihue; Waimea.

Oahu: Koko Head, Ewa Coral Plain, Moanalua (Bryan); Kai-muki (Ehrhorn); Wahiawa, Palolo (Illingworth); Waianae Mountains (Swezey); Woodlawn, Honolulu (F. X. Williams); Aiea; Waimanalo, Honolulu, Koko Head (Swezey); Kaneohe Bay (Whitney). Molokai: sea level (Swezey and Bryan). Maui.

Drs. Illingworth and Williams find that this ant feeds on sow-bugs (*Philoscia angusticauda* Budde-Lund). I have noted a similar habit in our North American *Leptogenys* (*Lobopelta*) *elongata* Buckley.

SUBFAMILY MYRMICINAE

9. *Pheidole megacephala* (Fabricius).

Formica megacephala Fabricius: Ent. Syst., vol. 2, p. 361, 1793-9, 2f.

Pheidole megacephala Forel: Fauna Hawaiiensis, vol. 1, p. 118, 1899. Perkins, Fauna Hawaiiensis, Int., pp. 83, 101, 140, 143, 217, 1913. Haw. Ent. Soc., Proc.: Perkins, vol. 1, p. 9, 1906; Kirkaldy, vol. 1, p. 100, 1907; Report, vol. 2, p. 296, 1913; Gulick, vol. 2, p. 308, appendix, 1913; Bridwell, vol. 3, p. 24, 1914; Illingworth, vol. 3, p. 24, 1914; Pemberton, vol. 3, p. 57, 1915; Warren, vol. 3, pp. 74, 78, 79, 1915; Illingworth, vol. 3, pp. 85, 113, 1915, pp. 142, 255, 1916, p. 349, 1917; Muir, vol. 3, pp. 180, 203, 1916; Bridwell, vol. 4, p. 311, 1920; Fullaway, vol. 5, p. 12, 1922; Ehrhorn, vol. 5, p. 18, 1922; Giffard, vol. 5, p. 54, 1922, pp. 184, 201, 1923; Crawford, vol. 5, p. 194, 1923, p. 361, 1924; Illingworth, vol. 5, pp. 273, 278, 1923, p. 350, 1924; Willard, vol. 5, p. 351, 1924; Illingworth, vol. 7, p. 45, 1928; Ehrhorn, vol. 6, p. 3, 1925; Illingworth, vol. 6, pp. 352, 357, 389, 396, 1927; Williams, vol. 6, pp. 426, 431, 1927; Timberlake, vol. 6, p. 556, 1927; Swezey and Bryan, vol. 7, p. 296, 1929. Timberlake: B. P. Bishop Mus., Bull. 31, p. 18, 1926.

Oahu: Honolulu (Thompson, Swezey); Manoa, Kolekole, Bishop Museum (Bryan); Waialae; Tantalus (Bridwell); Wahiawa (Illingworth); Manoa (Swezey); Kahuku, Waialua, Waianae Mountains, altitude 2,000 feet (Wheeler); Popoia Islet (Ball). Kauai: Kokee, altitude 4,000 feet, Kapaa (Kusche); Koloa; Lihue. Molokai: (Swezey and Bryan); Kaunakakai (Ball). Hawaii: Huehue and South Kona (Swezey), on *Campylothea*; Mauna Loa

(Illingworth); Kona (Wheeler); Kohala (Fullaway); Puu Kamaoa (Meinecke).

Midway Island: (Fullaway).

"All the islands from coast to elevation of 3,000 feet" (Perkins). In the Waianae Mountains I found a large colony of this ant which had stored in its nest great numbers of a small terrestrial amphipod.

10. *Solenopsis geminata rufa* (Jerdon).

Atta rufa Jerdon: Madras Lit. Soc., Jour., vol. 17, p. 106, 1851, ♀.

Solenopsis geminata race *rufa*, Forel: Fauna Hawaiiensis, vol. 1, p. 119, 1899.

Perkins: Fauna Hawaiiensis, Int., p. 101, 1913. Haw. Ent. Soc., Proc.: Lewis, vol. 2, p. 175, 1912; Ehrhorn, vol. 2, pp. 178, 296, 1912; Gulick, vol. 2, p. 308, appendix, 1913; Ehrhorn, vol. 3, p. 86, 1915; Fullaway, vol. 3, p. 284, 1917; Illingworth, vol. 3, pp. 350, 352, 1917, vol. 6, p. 389, 1927.

Oahu: Honolulu, Waianae, abundant; Wahiawa, Koko Head (Illingworth, Wheeler); Kamehameha School (Clarke); Wawamalu Beach, near Koko Crater, Alewa Heights; Kailua, Nanakuli, Pauoa (Bryan); Kaimuki, Ewa (Swezey).

11. *Monomorium floricola* (Jerdon).

Atta floricola Jerdon: Madras Lit. Soc., Jour., vol. 17, p. 107, 1851, ♀.

Monomorium floricola, Forel: Fauna Hawaiiensis, vol. 1, p. 119, 1899. Perkins: Fauna Hawaiiensis, Int., p. 101, 1913. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 182, 1912; Gulick, vol. 2, p. 308, 1913. Timberlake: B. P. Bishop Mus., Bull. 31, p. 17, 1926.

Oahu: Kaena Point (Swezey). Maui: Keanae and Iao Valley (Swezey).

Nihoa Island (Bryan) ♂ ♀ ♂ on *Pritchardia*, *Euphorbia* and *Sida*. Wake Island (Bryan) ♂.

Cited from "Oahu, Molokai, Lanai and Maui and probably all the islands" (Perkins).

12. *Monomorium fossulatum seychellense* Emery.

Monomorium fossulatum ~~seychellense~~ Emery: Soc. Ent. France, Ann., vol. 63, p. 69, fig., 1894, ♂ ♀. Haw. Ent. Soc., Proc.: Timberlake, vol. 6, p. 7, 1925; Swezey, vol. 6, p. 48, 1925, p. 219, 1926; Editor, vol. 6, p. 217, 1925.

Maui: Haiku (Swezey), in soil among sugar cane stools. Kauai: Grove Farm Plantation (Swezey). Oahu: Puuloa, ♂ ♀, in cane (Swezey); Makiki Valley (Bryan); Waialua; Honolulu, ♂ ♀ (Timberlake); Waipio, Kahuku; Puuloa (Van Zwaluwenburg). Hawaii: Honokaa ♂ (Pemberton); Haiku, at base of pineapple plants.

13. *Monomorium latinode* Mayr.

Monomorium latinode Mayr: Mus. Stor. Nat. Genova, Ann., vol. 2, 1872, ♀.
Haw. Ent. Soc., Proc.: Timberlake, vol. 6, p. 8, 1925; Editor, vol. 6, p. 217,
1925.

Oahu: Nuuanu Valley (Ehrhorn).

14. *Monomorium minutum* Mayr.

Monomorium minutum Mayr: Verh. zool.-bot. Ges., Wien, vol. 5, p. 453,
. 1855, ♀. Timberlake: B. P. Bishop Mus., Bull. 31, p. 17, 1926.

Laysan Island: (Fullaway) ♀. Midway Island (Fullaway) ♀.
Necker Island: (Bryan) ♀.

15. *Monomorium minutum* Mayr variety *liliuokalanii* Forel.

Monomorium minutum Mayr variety *liliuokalanii* Forel: Fauna Hawaiiensis,
vol. 1, p. 119, 1899, ♀. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 207,
1913; Gulick, vol. 2, p. 308, 1913, appendix.

Oahu: Honolulu (type locality); Manoa and Barbers Point
(Swezey); Kaimuki (Ehrhorn); Koko Head (Wheeler). Kauai:
(Illingworth). Hawaii: Hilo (Swezey).

16. *Monomorium pharaonis* (Linnaeus).

Formica pharaonis Linnaeus: Syst. Nat., ed. 10, vol. 1, p. 580, 1758, ♀.
Monomorium pharaonis, Mayr: Verh. zool.-bot. Ges. Wien, vol. 12, p. 752,
1862. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 182, 1912; Gulick, vol. 2,
p. 308, 1913, appendix; Illingworth, vol. 6, p. 237, 1926. Timberlake:
B. P. Bishop Mus., Bull. 31, p. 18, 1926.

Oahu: in houses. Hawaii: Kilauea, in fern forest (Bryan);
Naalehu, in cane; Hilo.

French Frigates Shoal: (Bryan) ♀. Wake Island, including
Peale and Wilkes islands: (Bryan) ♀. Johnston Island: (Bryan)
♀ ♀ ♂.

17. *Monomorium* (*Parholcomyrmex*) *destructor* (Jerdon).

Atta destructor Jerdon: Madras Lit. Soc., Jour., vol. 17, p. 105, 1851, ♀.
Monomorium destructor, Forel: Fauna Hawaiiensis, vol. 1, p. 110, 1899, ♀.
Perkins: Fauna Hawaiiensis, Int., p. 101, 1913. Ehrhorn: Haw. Ent. Soc.,
Proc., vol. 2, p. 182, 1912. Timberlake: B. P. Bishop Mus., Bull. 31, p. 17,
1926.

Kauai: Kekaha, in cane. Oahu: Honolulu (Whitney, Ehrhorn);
Kaimuki.

Laysan Island (Fullaway) ♀.

18. *Monomorium (Parholcomyrmex) gracillimum* (F. Smith).

Myrmica gracillima F. Smith: Linn. Soc. London, Jour. Proc., vol. 6, p. 34, 1861, ♀. Emery: Zool. Jahrb., Syst., vol. 12, p. 438, 1899, ♀.

Laysan Island: (Schauinsland; Fullaway) ♀.

19. *Cardiocondyla nuda* Mayr variety *minutior* Forel.

Cardiocondyla nuda Mayr variety *minutior* Forel: Fauna Hawaiiensis, vol. 1, p. 120, 1899, ♀. Perkins: Fauna Hawaiiensis, Int., p. 101, 1913. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 308, 1913; Illingworth, vol. 7, p. 45, 1928; Swezey and Bryan, vol. 7, p. 296, 1929. Timberlake: B. P. Bishop Mus., Bull. 31, p. 18, 1926.

Oahu: Honolulu (type locality); Wahiawa, Waianae (Illingworth); Palolo (Bridwell); Honolulu, Punaluu, Makaleha, Mount Kaala, Barbers Point, Mount Olympus, Waimanalo, Lanihuli, Kuliouou (Swezey); Manoa (Ehrhorn). Molokai: Kaunakakai (Swezey and Bryan). Lanai: in pineapple fields. Maui: Paia (Swezey). Kauai: Kalalau, Awaawapuhi (Bryan). Hawaii: Kilauea (Swezey, Wheeler); Hilo Sugar Company (Swezey); Kona (Wheeler).

Midway Island (Fullaway) ♀. Necker Island (Bryan) ♀. French Frigates Shoal ♀ ♀.

20. *Cardiocondyla wroughtoni* Forel variety *hawaiiensis* Forel.

Cardiocondyla wroughtoni Forel variety *hawaiiensis* Forel: Fauna Hawaiiensis, vol. 1, p. 119, 1899, ♀. Perkins: Fauna Hawaiiensis, Int., p. 101, 1913. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 308, 1913; Swezey and Bryan, vol. 7, p. 296, 1929.

Molokai: Kaunakakai, in alfalfa fields (type locality); Kawela (Swezey); Kainalu (Swezey and Bryan). Oahu (Van Zwaluwenburg): Nuuanu Pali, in dead twig of *Pipturus*; Waialae Nui, west side of Mount Kaala, Mount Kaala, Pupukea, Tantalus (Swezey); Honolulu, Waialua (Bryan); Koko Head (Wheeler). Kauai: Kapaa (Illingworth); Koloa. Maui: Iao Valley (Swezey). Hawaii: Honaunau (Stokes); Paauilo, altitude 2,500 feet (Williams).

21. *Tetramorium guineense* (Fabricius).

Formica guineensis Fabricius: Ent. Syst., vol. 2, p. 357, 1793, ♀.

Tetramorium guineense, Mayr: Verh. zool.-bot. Ges., Wien, vol. 12, p. 740, 1862. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 308, appendix, 1913; Swezey, vol. 3, p. 16, 1914; Perkins, vol. 1, p. 33, 1906; Ehrhorn, vol. 2, pp. 182, 1912, 207, 1913; Fullaway, vol. 3, p. 20, 1914; Bridwell, vol. 3, p. 383, 1918; Swezey and Bryan, vol. 7, p. 296, 1929. Timberlake: B. P. Bishop Mus., Bull. 31, p. 18, 1926.

Oahu: Honolulu; Ewa; Waiahole (Swezey). Kauai: (Illingworth). Maui: Kipahulu. Molokai: forests (Swezey and Bryan). Hawaii: Waiakea; Hilo; Hakalau; Pepeekeo; Papaikou.

Nihoa Island (Bryan, Cooke, Thaanum) ♂ ♀. Necker Island (Bryan) ♂ ♀ ♂. Midway Island (Fullaway) ♀. Laysan Island (Fullaway, Schauinsland, Wilder) ♀. Pearl and Hermes Reef (Fullaway) ♀. Ocean Island (Fullaway) ♀.

22. *Tetramorium simillimum* (F. Smith).

Myrmica simillima F. Smith: List Brit. Anim. Brit. Mus., pt. 6, Acul., p. 118, 1851, ♀.

Tetramorium simillimum, Mayr: Europ. Formicid., p. 61, 1861, ♀.

Oahu: Waianae Plantation (Swezey).

23. *Tetramorium tonganum* Mayr.

Tetramorium tonganum Mayr: Verh. K. K. zool.-bot. Ges. Wien, vol. 20, pp. 970-972, 1870, ♀. Haw. Ent. Soc., Proc.: Swezey, vol. 6, pp. 356, 367, 1927; Editor, vol. 6, p. 558, 1927.

Oahu: Manoa Substation, Haw. Sugar Plant. Assoc., altitude 500 feet, in sugar cane stalk bored by *Rhabdocnemis obscura* (Boisduval) (Swezey).

24. *Strumigenys lewisi* Cameron.

Strumigenys lewisi Cameron: Manchester Phil. Soc., Proc., p. 229, 1887, ♂ ♀. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 195, 1913 ("Japanese immigrant"); Bridwell, vol. 3, p. 383, 1918; Williams, vol. 4, p. 453, 1921.

Oahu: Palolo Valley (Bridwell); Manoa, altitude 900 feet, and Waihi Falls, Manoa Valley (Williams).

25. *Strumigenys (Cephaloxys) membranifera* Emery variety *williamsi* Wheeler.

Strumigenys (Cephaloxys) membranifera Emery variety *williamsi* Wheeler: Haw. Ent. Soc., Proc., vol. 8, p. 276, 1933, fig., ♂ ♀.

Hawaii: off road to Puna, south of Olaa, type locality (Williams) ♂ ♀.

26. *Epitritus wheeleri* Donisthorpe.

Epitritus wheeleri Donisthorpe: Ent. Record, vol. 28, p. 121, 1916, ♀. Timberlake: Haw. Ent. Soc., Proc., vol. 6, p. 7, 1925.

Oahu: Honolulu (type locality); Waimanalo, in cane stool (Swezey).

SUBFAMILY DOLICHODERINAE

27. *Tapinoma (Micromyrma) melanocephalum* (Fabricius).

Formica melanocephala Fabricius: Ent. Syst., vol. 2, p. 353, 1793, ♀.

Tapinoma melanocephalum, Mayr: Verh. zool.-bot. Ges. Wien, vol. 12, p. 651, 1862, ♀. Fauna Hawaiiensis; Forel, vol. 1, p. 120, 1899; Perkins, Int., p. 102, 1913. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 310, 1913; Fullaway, vol. 3, p. 20, 1914; Illingworth, vol. 7, p. 45, 1928. Timberlake: B. P. Bishop Mus., Bull. 31, p. 18, 1926.

Oahu: Honolulu; Waianae (Fullaway); Kapahulu (Ehrhorn); Koko Head (Illingworth, Wheeler); Wahiawa, Waianae (Illingworth); Kaimuki; Tantalus, Ewa, Waianae (Swezey). Lanai. Molokai. Hawaii: Hilo (Ehrhorn).

Nihoa Island (Bryan) ♀. Midway Island (Fullaway) ♀. Ocean Island (Fullaway) ♀. Laysan Island (Schauinsland) ♀.

28. *Technomyrmex albipes* (F. Smith).

Formica (Tapinoma) albipes F. Smith: Linn. Soc. London, Zool., Jour. Proc., vol. 6, p. 38, 1861, ♀.

Technomyrmex albipes, Emery: Zeit. wiss. zool., vol. 46, p. 392, 1888. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 237, 1913, vol. 3, p. 14, 1914; Gulick, vol. 2, p. 310, 1913; Swezey, vol. 3, p. 56, 1915; Swezey and Bryan, vol. 7, p. 296, 1929.

Kauai: Kilauea (Swezey); Lihue. Oahu: Manoa, Maunawili (Ehrhorn); Hauula, Nuuanu, Waimano (Swezey); Laie (Ivins). Hawaii: Laupahoehoe (Swezey); South Kona (Swezey, Giffard); Hakalau; Kilauea. Molokai: forests (Swezey and Bryan).

SUBFAMILY FORMICINAE

29. *Plagiolepis exigua* Forel.

Plagiolepis exigua Forel: Bombay Nat. Hist. Soc., Jour., vol. 8, pp. 415, 417, 1894, ♀ ♀. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, pp. 182, 207, 1913; Gulick, vol. 2, p. 310, 1913, appendix; Fullaway, vol. 3, p. 17, 1915; Report, vol. 4, p. 609, 1921.

Oahu: Makiki, Kalihi, Aiea, Tantalus. Hawaii: Naalehu.

30. *Plagiolepis mactavishi* Wheeler.

Plagiolepis mactavishi Wheeler: Am. Mus. Nat. Hist., Bull., vol. 24, p. 166, 1908, ♀. Haw. Ent. Soc., Proc.: Ehrhorn, vol. 2, p. 207, 1913; Gulick, vol. 2, p. 310, appendix, 1913; Swezey and Bryan, vol. 7, p. 296, 1929.

Oahu: (Van Zwaluwenburg); Honolulu (Ehrhorn); Koko Head (Wheeler). Molokai: forests (Swezey and Bryan). Kauai: Kapaa, in pineapple fields (Illingworth).

31. *Brachymyrmex heeri* variety *aphidicola* Forel.

Brachymyrmex heeri variety *aphidicola* Forel: Deutsch. Ent. Zeit., p. 263, 1909, ♀. Haw. Ent. Soc., Proc.: Timberlake, vol. 6, p. 13, 1925; Editor, vol. 6, p. 217, 1925.

Oahu: Honolulu, in orchid baskets (Lyon).

32. *Camponotus (Tanaemyrmex) variegatus hawaiiensis* Forel.

Camponotus maculatus hawaiiensis Forel: Fauna Hawaiiensis, vol. 1, p. 122, 1899, ♀ ♀ ♂. Haw. Ent. Soc., Proc.: Kuhns, vol. 2, p. 93, 1910; Report, vol. 2, p. 296, 1913; Gulick, vol. 2, p. 310, appendix, 1913; Illingworth, vol. 6, p. 396, 1927.

Oahu: Honolulu (type locality) in and around houses; Koko Head (Illingworth, Wheeler); Ewa Coral Plain, Kolekole (Bryan); Nuuanu (Bickerton), Manoa and Honolulu (Ball); Waianae (Illingworth). Maui. Molokai: Mauna Loa, in pineapple fields (Illingworth); Kaunakakai (Ball). Hawaii (Ehrhorn): altitude 4,000 feet (Kusche).

33. *Paratrechina longicornis* (Latreille).

Formica longicornis Latreille: Hist. Nat. Fourmis, p. 113, 1802, ♀.

Prenolepis longicornis, Forel: Fauna Hawaiiensis, vol. 1, p. 120, 1899. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 310, appendix, 1913; Illingworth, vol. 3, pp. 350, 352, 1917; Report, vol. 4, p. 609, 1921; Hebard, vol. 6, p. 302, 1926. Timberlake: B. P. Bishop Mus., Bull. 31, p. 19, 1926.

Oahu: Koko Head, Moanalua, Palolo, Waianae (Illingworth); Koko Head (Wheeler); Barbers Point, Bishop Museum (Swezey); Ewa Coral Plain, Wawamalu Beach near Koko Head (Bryan); Kaimuki (Thompson, Swezey); Aiea. Maui: Kipahulu. Kauai: Kapaa, in pineapple fields (Illingworth). Hawaii: north Kona, altitude 5,000-7,000 feet (Wilder).

Nihoa Island (Bryan) ♀.

Simultaneously with the introduction of this ant into the Hawaiian islands, two of its myrmecophiles were introduced, a small beetle, *Coluocera maderae* Wollaston and a small cricket, *Myrmecophila americana* Saussure (= *M. prenolepidis* Wasmann). These were taken in the nests at Koko Head by Dr. Illingworth and myself.

34. *Paratrechina (Nylanderia) bourbonica hawaiiensis* Forel.

Prenolepis bourbonica hawaiiensis Forel: Fauna Hawaiiensis, vol. 1, p. 120, 1899, ♀ ♀ ♂. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 310, appendix, 1913; Swezey and Bryan, vol. 6, p. 414, 1927, vol. 7, p. 296, 1929. Timberlake: B. P. Bishop Mus., Bull. 31, p. 19, 1926.

Oahu (type locality): Honolulu, common; west Kalihi Ridge, Waimalu and Manoa (Bryan), Kaumuahona, south Waianae Moun-

tains, Mount Olympus (Swezey); Nuuanu (Bridwell); Waipio, Wahiawa (Illingworth); Koko Head and Waikiki beach (Wheeler); Ewa; Punaluu; Waimano. Molokai: Kaunakakai, altitude 2,400 feet on *Metrosideros*. Hawaii: Kilauea (Wheeler). Maui: Keanae (Swezey). Kauai: Kalalau (Bryan); Alakai Swamp (Forbes). Hawaii; Puu Kamaoa (Meinecke).

Midway Island (Fullaway) ♂. Wake Island on *Cordia* and *Pemphis* (Bryan) ♂ ♀.

35. *Paratrechina (Nylanderia) sharpi* Forel.

Prenolepis sharpi Forel: Fauna Hawaiiensis, vol. 1, p. 121, fig., 1899, ♂ ♀ ♂. Haw. Ent. Soc., Proc.: Gulick, vol. 2, p. 310, appendix, 1913. Perkins: Fauna Hawaiiensis, Int., p. 102, 1913.

Oahu: Honolulu, type locality (Lewis); "brought with plants from China" (Perkins); Kaimuki, Manoa (Swezey).

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INDO-PACIFIC TERRESTRIAL TALIPIDAE

By

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INDO-PACIFIC TERRESTRIAL TALITRIDAE

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In other papers I have described terrestrial Talitridae from the Marquesas and Society Islands (41)¹ in the south-central Pacific. I now wish to list the species from the Indo-Pacific area as a whole and to compare the talitrid fauna of this region with that of the Atlantic, as well as to add some remarks on special "terrestrial" characters.

All terrestrial Talitridae belong to the genera *Talitrus*, *Orchestia*, *Parorchestia*, and *Talorchestia*, but not all species of these genera are terrestrial. Several of them live on the seashore, others in fresh water, and for a few there is no information available regarding habits.

A number of species have been recorded only once and are not well described, or only a single sex is known. An excellent character—not always taken into consideration—seems to be the presence or absence of marginal spines on the outer ramus of uropod 1; this character, therefore, is mentioned below under each species.

Genus TALITRUS Latreille

1. *Talitrus alluaudi* Chevreux.

Talitrus alluaudi Chevreux: Soc. Zool. France, Mém., vol. 14, p. 389, figs., 1901. Stebbing: Das Tierreich, Lief. 21, p. 525, 1906. Stephensen: Vid. Meddel. Dansk Naturh. Foren., Copenhagen, vol. 78, pp. 197-199 (literature and synonymy), 1925. Chevreux and Fage: Amphipodes, Faune de France, no. 9, p. 270, 1925. Hunt: Mar. Biol. Assoc., Plymouth, Jour., vol. 13, no. 4, p. 855, figs., 1925.

Uropod 1 has no marginal spines on the outer ramus. The pleopoda are reduced (5, p. 389, with figs.; 8, p. 270, with figs.).

A. In the open air. Seychelles, in damp soil in the forests, etc.; Madagascar, several localities up to 500 meters; Java, Buitenzorg; Mangareva; Tuamotus (about 23° S., 135° W.).

B. In damp soil in hothouses. Europe (39). Also Sweden: Uppsala, the Botanical garden (kindly communicated by Prof. O.

¹ Numbers in parentheses refer to Literature Cited, p. 18.

Lundblad, Stockholm); Germany, Berlin-Dahlem (25, p. 500); France, several places (8); Great Britain, Lancashire and Cheshire (45); Hungary (23, p. 377); North America, Ohio (47, p. 560).

2. *Talitrus kershawi* Sayce.

Talitrus kershawi Sayce: Roy. Soc. Victoria, Proc., vol. 22, new ser., pt. 1, p. 32, figs., 1909.

Uropod 1 has no marginal spines on the outer ramus. The pleopoda are rudimentary. Victoria (26): "I have gatherings from a considerable number of localities throughout Victoria. They are often associated with *T. sylvaticus*, and rather more numerous than that species." Terrestrial.

3. *Talitrus sylvaticus* Haswell.

Talitrus sylvaticus Haswell, Stephensen: B. P. Bishop Mus., Bull. 142, art. 3.

Genus *ORCHESTIA* Leach

1. *Orchestia bollonsi* Chilton.

Orchestia bollonsi Chilton: The subantarctic islands of New Zealand, vols. 1, 2, p. 635, figs., 1909.

Uropod 1 has marginal spines on the outer ramus. Subantarctic islands of New Zealand and other islands near New Zealand, under wood and stones, and under guano.

2. *Orchestia chiliensis* Milne-Edwards.

Orchestia chiliensis Milne-Edwards, Stebbing: Das Tierreich, Lief. 21, p. 537, 1906. Schellenberg: Swedish Antarctic Exped. 1901-1903, vol. 2, no. 6, p. 224, 1931.

Uropod 1 has marginal spines on the outer ramus (specimens from New Zealand in the Zoological Museum of Copenhagen, determined by Charles Chilton). Chile, several places, under stones and in small pools between tide marks; Strait of Magellan, Juan Fernandez, New Zealand, "extremely common in most places on the sea shore, and does not seem to extend far beyond high water mark, although under favorable conditions it may be found at some little distance from the beach" (14, p. 81); Chatham Island, east of New Zealand (19, p. 318).

2a. *Orchestia chiliensis* Milne-Edwards variety *gracilis* Chilton.

Orchestia chiliensis gracilis Chilton: Nat. Hist. Juan Fernandez and Easter Island, vol. 3, p. 86, figs., 1921.

Uropod 1 not described. Juan Fernandez: Masatierra, under stones, altitude about 590 meters.

3. *Orchestia costaricana* Stebbing.

Orchestia costaricana Stebbing: U. S. Nat. Mus., Proc., vol. 31, p. 501, figs., 1906.

Uropod 1 has no marginal spines on the outer ramus (according to the figure; not mentioned in the text). Costa Rica: Boca Jesus Maria (on the Pacific coast?) in mangroves in the mud under trunks of trees.

4. *Orchestia ditmari* Derzhavin.

Orchestia ditmari Derzhavin: Russ. Hydrobiol. Zeitschr., vol. 2, p. 187, figs., 1923.

Uropod 1 has 3 marginal spines on the outer ramus. Kamtschatka, fresh water.

5. *Orchestia floresiana* Max Weber.

Orchestia floresiana Weber, Stephensen: B. P. Bishop Mus., Bull. 142, art. 3.

5a. *Orchestia floresiana monospina* Stephensen.

Orchestia floresiana monospina Stephensen: B. P. Bishop Mus., Bull. 142, art. 3.

6. *Orchestia gambariensis* Chevreux.

Orchestia gambariensis Chevreux: Soc. Zool. France, Mém., vol. 20, p. 491, figs., 1908.

Uropod 1 has marginal spines on the outer ramus. Tuamotus; Mangareva, Rikitea, about 23° S., 135° W., under stones and decaying algae on the shore.

7. *Orchestia gammarellus* (Pallas).

Orchestia gammarellus (Pallas), Stebbing: Das Tierreich, Lief. 21, p. 532, 1906. Chevreux and Fage, Amphipodes: Faune de France, no. 9, p. 275, figs., 1925.

Uropod 1 has marginal spines on the outer ramus. Littoral, in damp soil up to 800 meters (33, p. 467). Widely distributed along the Atlantic coasts. Stebbing (36, p. 533) writes: "? South Pacific (Illawara, New South Wales), seashores."

8. *Orchestia humicola* Martens.

Orchestia humicola Martens, Stebbing: Das Tierreich, Lief. 21, p. 539, 1906.

Uropod 1 has no marginal spines on the outer ramus. Japan, among damp fallen leaves.

9. *Orchestia japonica* (Tattersall).

Talorchestia japonica Tattersall: Asiatic Soc. Bengal, Calcutta, Mem., vol. 6, p. 452, figs., 1922.

Uropod 1 has no marginal spines on the outer ramus. The eyes are reduced: "Some of the specimens have the pigment of the eyes imperfectly developed and irregularly arranged. Chilton (10, p. 167) has called attention to similar specimens of *Talorchestia parvispinosa*" (43). Is probably an *Orchestia*, for there is a marked palm on pereopod 1 of female (Tattersall: "2nd thoracic limb of female," 1922, pl. 21, fig. 1). Japan: Hondo, Lake Biwa, among damp weeds on the shore.

10. *Orchestia kokuboi* Uéno.

Orchestia kokuboi Uéno: Sci. Rep. Tohoku Imp. Univ., 4th ser., Biol., vol. 4, no. 1, fasc. 1, p. 7, figs., 1929.

Uropod 1 has marginal spines on the outer ramus. Japan: terrestrial, on a hill in Yu-no-shima, a small island off Asamushi ("about 40° 70' N"). "This spot is far above the tide marks; and the animals were found living in burrows in soft damp soil under dead leaves."

11. *Orchestia malayensis* (Tattersall).

Talorchestia malayensis Tattersall: Asiatic Soc. Bengal, Calcutta, Mem., vol. 6, p. 453, figs., 1922.

Orchestia malayensis (Tattersall), Schellenberg: Archiv f. Hydrobiol., Suppl. Bd. 8, "Tropische Binnengewässer Bd. I," p. 502, fig. 2, o-p, 1931.

Uropod 1 has no marginal spines on the outer ramus. Singapore: Botanical Gardens, among dead leaves on ground in the shade of trees, on damp walls of drain and on damp earth under logs (type locality; not recorded anywhere else).

Orchestia malayensis (Tattersall) variety *thienemanni* Schellenberg = *O. floresiana* Weber. Stephensen: B. P. Bishop Mus., Bull. 142, art 3, figs. 4-6.

12. *Orchestia marmorata* (Haswell).

Orchestia marmorata (Haswell), Stebbing: Das Tierreich, Lief. 21, p. 536, 1906.

Uropod 1 not described. Tasmania, on the seashore.

13. *Orchestia marquesana* Stephensen.

Orchestia marquesana Stephensen: B. P. Bishop Mus., Bull. 142, art 3, figs. 8-10.

14. *Orchestia miranda* Chilton.

Orchestia miranda Chilton: New Zealand Inst., Trans., vol. 48, p. 354, figs., 1916.

Uropod 1 has marginal spines on the outer ramus. New Zealand: Stephen Island, Cook Strait, on rocky shores.

15. *Orchestia montana* Max Weber.

Orchestia montana Max Weber: Zool. Ergebn., vol. 2, p. 567, figs., 1892. Stebbing: Das Tierreich, Lief. 21, p. 542, 1906.

Uropod 1 has no marginal spines on the outer ramus. South Celebes: under stones and fallen leaves, altitude 1,150 meters.

16. *Orchestia nitida* Dana.

Orchestia nitida Dana, Stebbing: Das Tierreich, Lief. 21, p. 539, 1906. Schellenberg: Swedish Antarctic Exped. 1901-1903, vol. 2, no. 6, p. 224, fig., 1931.

Uropod 1 has no marginal spines on the outer ramus. Tierra del Fuego: among floating *Fucus*, on or near the shores; Port Famine.

17. *Orchestia parvispinosa* Max Weber.

Orchestia parvispinosa Max Weber: Zool. Ergebn., vol. 2, p. 566, figs., 1892. Stebbing: Das Tierreich, Lief. 21, p. 541, 1906. Schellenberg: Swedish Antarctic Exped. 1901-1903, vol. 2, no. 6, p. 502, 1931.

Uropod 1 has marginal spines on the outer ramus. Java: Mount Salak, altitude 1,575 meters, under stones and decaying timber; type locality; 3 places, up to 2,000 and 2,400 meters, in a fountain and a waterfall (Schellenberg).

Not *O. parvispinosa* Chilton (10); according to Schellenberg (30) = *O. malayensis* (Tattersall) variety *thienemanni* Schellenberg.

18. *Orchestia pickeringi* Dana.

Orchestia pickeringi Dana, Stebbing: Das Tierreich, Lief. 21, p. 538, 1906.

Uropod 1 has no marginal spines on the outer ramus. Hawaiian islands: up to 2,000 feet (35, p. 528); Dana's type specimens were from Kauai or Oahu, "Sandwich islands," without further comments. California, New South Wales, among decaying seaweed, etc.

O. pickeringi Dana is considered synonymous with *O. platensis* Kroyer, species no. 19, by Chilton (15, p. 538), but not by later authors.

19. *Orchestia platensis* Kroyer.

Orchestia platensis Kroyer, Stebbing: Das Tierreich, Lief. 21, p. 540, 1906. Chevreux and Fage: Faune de France, no. 9, p. 276, figs., 1925. Schellenberg: Deutsche Südpolar-Exped. 1901-1903, vol. 18, (Zool. vol. 10), p. 371, 1926. Schellenberg: Zool. Soc. London, Trans., pt. 5, p. 658 (literature and synonymy), 1928. Barnard: South African Mus., Ann., vol. 15, pt. 3, p. 218 (literature and synonymy), 1932.

Uropod 1 has no marginal spines on the outer ramus. Widely distributed in the Atlantic and adjacent waters, along the shores (2), but also recorded from several places in the Indo-Pacific Ocean. India, Chilka Lake, brackish water, on the shore, very abundant (15, p. 538, figs.). Maldivé Archipelago, Mahlosmadulu Atoll, 20 fathoms (?) (48, p. 924, fig.). The depth, 20 fathoms, is possibly not correct (15, p. 540). Bali, Batur Lake, 1,031 meters, frequent on the shore under stones, etc. (29, p. 503, figs.). Tuamotus, South Marutea (about 20° S., 135° W.), the lagoon, on the sandy beach. Mangareva, Taravai, east coast (6, p. 494, figs.). Hawaiian islands, several localities, up to 2,000 to 3,000 feet (35, p. 527).

Recorded with some doubt from the New Hebrides, 6,000 feet (44, p. 96), but as stated by Schellenberg (31, p. 63), the specimens can not belong to the species in question, for they are recorded to have marginal spines on the outer ramus of uropod 1. Possibly the specimens could belong to the species *O. parvispinosa* Weber?

20. *Orchestia selkirki* Stebbing.

Orchestia selkirki Stebbing: Das Tierreich, Lief. 21, p. 538, 1906.

Uropod 1 has marginal spines on the outer ramus. Juan Fernandez, on the shore.

A valid species (30, p. 224), not identical with *O. chiliensis* Milne-Edwards as suggested by Chilton (14, p. 83).

21. *Orchestia serrulata* Dana.

Orchestia serrulata Dana, Stebbing: Das Tierreich, Lief. 21, p. 535, 1906. Stephensen: Vid. Meddel. Dansk Naturh. Foren., Copenhagen, vol. 83, p. 347, 1927.

Uropod 1 has marginal spines on the outer ramus. New Zealand, Auckland and Campbell Islands, among seaweed and under stones between tide marks.

Probably *O. serrulata* Dana = *O. chiliensis* Milne-Edwards (14, p. 82, figs.); possibly = *O. aucklandiae* Bate.

22. *Orchestia traskiana* Stimpson.

Orchestia traskiana Stimpson, Stebbing: Das Tierreich, Lief. 21, p. 534, 1906.

Uropod 1 has marginal spines on the outer ramus. San Francisco, among the rejectamenta along highwater mark.

23. *Orchestia tucurauna* F. Müller.

Orchestia tucurauna F. Müller, Stebbing: Das Tierreich, Lief. 21, p. 534, 1906. Chilton: Ann. Mag. Nat. Hist., 9th ser., vol. 3, p. 376, 1919, seq., figs., with literature, including the following synonyms: *O. sulcsoni* Stebbing (36, p. 541), and (?) *O. dentata* Filhol (36, p. 537).

Uropod 1 has marginal spines on the outer ramus. South Brazil (type locality), ? Madeira (36). New Zealand: banks near the mouth of the Waitohi stream at Picton (13); Chatham Island (19, p. 318); Kapiti Island (?) (Cook Strait; Filhol). According to Chilton's figure (13, p. 5) of pereopod 1 ("gnathopod 1") of the female which has no palm, the species seems to belong to the genus *Talorchestia*.

Genus **TALORCHESTIA** Dana

1. *Talorchestia antennulata* Chevreux.

Talorchestia antennulata Chevreux: Nova Caled. Zool., vol. 2, livr. 1, no. 1, p. 4, figs., 1915.

Uropod 1 has no marginal spines on the outer ramus. New Caledonia: numerous localities, up to 1,600 meters, under decaying leaves. Loyalty Islands: Mare, Raoua.

2. *Talorchestia diemensis* Haswell.

Talorchestia diemensis Haswell, Stebbing: Das Tierreich, Lief. 21, p. 548, 1906.

Uropod 1 not described. New Caledonia, west coast (7, p. 4); Tasmania (Haswell).

3. *Talorchestia gracilis* (Dana).

Talorchestia gracilis (Dana), Stebbing: Das Tierreich, Lief. 21, p. 531, 1906.

Uropod 1 has no marginal spines on the outer ramus. Coral Island in the Balabac Passage (north of Borneo; Dana). North Siam: Lake Tale Sap (17). India: Chilka Lake (15).

T. gracilis (Dana) = *T. martensi* Chilton (15, p. 541) not Weber (49, p. 564, figs.); see Chilton (17, p. 535).

4. *Talorchestia kemp*i Tattersall.

*Talorchestia kemp*i Tattersall: Indian Mus., Rec., vol. 8, pt. 5, no. 35, p. 449, figs., 1914.

Uropod 1 has no marginal spines on the outer ramus. Northeast Assam: semi-terrestrial; under stones, and near Sireng stream.

*T. kemp*i Tattersall is near *Orchestia parvispinosa* Max Weber.

5. *Talorchestia limicola* Haswell.

Talorchestia limicola Haswell, Stebbing: Das Tierreich, Lief. 21, p. 547, 1906.

Uropod 1 not described. Queensland: Bowen, in mangrove swamps, under decaying wood, etc.

6. *Talorchestia martensi* (Max Weber).

Talorchestia martensi (Max Weber), Stebbing: Das Tierreich, Lief. 21, p. 553, 1906.

Uropod 1 "not markedly different from those of *Orchestia florensiana*"; outer ramus has no marginal spines. Flores: under stones in and at the margin of the rivulet Lella.

Not *T. martensi* Chilton (15); see Chilton (17, p. 535) = *T. gracilis* Dana.

7. *Talorchestia novaehollandiae* Stebbing.

Talorchestia novaehollandiae Stebbing: Das Tierreich, Lief. 21, p. 553, 1906.

Uropod 1 has marginal spines on the outer ramus. East Australia: Manly Beach.

8. *Talorchestia pollicifera* (Stimpson).

Talorchestia pollicifera (Stimpson), Stebbing: Das Tierreich, Lief. 21, p. 550, 1906.

Uropod 1 not described. North Pacific: Loo Choo.

9. *Talorchestia pravidactyla* Haswell.

Talorchestia pravidactyla Haswell, Stebbing: Das Tierreich, Lief. 21, p. 546, 1906.

Uropod 1 has marginal spines on the outer ramus. Tasmania.

10. *Talorchestia quadrimana* (Dana).

Talorchestia quadrimana Dana, Stebbing: Das Tierreich, Lief. 21, p. 548, 1906.

Uropod 1 has no marginal spines on the outer ramus. Australia: New South Wales; Queensland (Port Denison); on sandy beaches.

11. *Talorchestia quoyana* (Milne-Edwards).

Talorchestia quoyana (Milne-Edwards), Stebbing: Das Tierreich, Lief. 21, p. 547, 1906. Chilton: New Zealand Inst., Trans., vol. 49, p. 294, figs., 1917.

Uropod 1 has marginal spines on the outer ramus. New Zealand, on sandy beaches.

12. *Talorchestia rectimana* (Dana).

Talorchestia rectimana Dana: Amer. Acad. Arts and Sci., Proc., vol. 2, p. 203, 1852. U. S. Expl. Exp., vol. 13, p. 877, 1855. Stebbing: Das Tierreich, Lief. 21, p. 543, 1906 (= *Orchestia rectimana*, *O. tahitensis*). Chevreux: Soc. Zool. France, Mém., vol. 20, p. 495, 1908. Stephensen: B. P. Bishop Mus., Bull. 113, figs., 1935.

Uropod 1 has marginal spines on the outer ramus. Tahiti: various localities, from sea level up to 600 meters, in damp places, under stones. Not known from elsewhere.

13. *Talorchestia sinensis* Chilton.

Talorchestia sinensis Chilton: China Jour. Sci. and Arts, vol. 3, no. 5, p. 283, figs., 1925.

Uropod 1 not described. China: without special information on occurrence, etc.

14. *Talorchestia spinipalma* (Dana).

Talorchestia spinipalma (Dana), Stebbing: Das Tierreich, Lief. 21, p. 552, 1906.

Uropod 1 has no marginal spines on the outer ramus. New Caledonia: Noumea (7, p. 4). Tropical Pacific: Tongatabu, about 21° S., 175° W., under seaweed. Queensland: Port Denison, on sandy beach.

15. *Talorchestia telluris* (Bate).

Talorchestia telluris (Bate), Stebbing: Das Tierreich, Lief. 21, p. 551, 1906. Chilton: New Zealand Inst., Trans., vol. 49, p. 299, figs., 1917.

Uropod 1 has (?) marginal spines on the outer ramus. New Zealand: on sandy shores.

16. *Talorchestia tridentata* Stebbing.

Talorchestia tridentata Stebbing: Das Tierreich, Lief. 21, p. 546, 1906.

Uropod 1 has no marginal spines on the outer ramus. California: without further information (but found among specimens of *Orchestia traskiana*).

17. *Talorchestia tumida* G. M. Thomson.

Talorchestia tumida G. M. Thomson, Stebbing: Das Tierreich, Lief. 21, p. 550, 1906. Chilton: New Zealand Inst., Trans., vol. 49, p. 295, figs., 1917.

Uropod 1 has marginal spines on the outer ramus. New Zealand: on sandy beaches, above high-water mark. Chatham Island (19, p. 318).

***Talorchestia* species, Tattersall.**

Talorchestia species, Tattersall: Asiatic Soc. Bengal, Mem., vol. 6, p. 455, 1922.

China: Si Dong Ding, Tai-Hu, under vegetable débris on the shore.

T. japonica Tattersall (43) is probably an *Orchestia*; see *O. japonica* (Tattersall).

Genus PARORCHESTIA Stebbing

The species of this genus have no marginal spines on the outer ramus of uropod 1, except *P. luzonensis* Baker; this is probably an *Orchestia* (see below, species 5).

1. **Parorchestia hawaiiensis** (Dana).

Parorchestia hawaiiensis (Dana), Stebbing: Das Tierreich, Lief. 21, p. 558, 1906.

Hawaiian islands: several localities (Dana; 35, p. 529), terrestrial.

2. **Parorchestia improvisa** Chilton.

Parorchestia improvisa Chilton: Subantarctic islands of New Zealand, vol. 2, p. 641, fig., 1909.

Snares and Stewart Islands east of New Zealand; no record on habits.

3. **Parorchestia insularis** Chilton.

Parorchestia insularis Chilton: Subantarctic islands of New Zealand, vol. 2, p. 639, figs., 1909. Stephensen: Vid. Meddel. Dansk Naturh. Foren., Copenhagen, vol. 83, p. 349, 1927.

Auckland and Campbell islands: under wood, and "extremely abundant right up to the top of the highest hills."

4. **Parorchestia lagunae** Baker.

Parorchestia lagunae Baker: Philip. Jour. Sci., sect. D., vol. 10, p. 254, figs., 1915.

Luzon: Laguna Province, shores of the fresh water lake, Bay Lake, under stones at water margin, only encountered on rocky shores. The pleopods are said to be large and normal.

5. **Parorchestia luzonensis** Baker.

Parorchestia luzonensis Baker: Philip. Jour. Sci., sect. D, vol. 10, p. 253, figs., 1915.

P. luzonensis is probably an *Orchestia*; the maxillipeds have not a 4-joint in the palp (1, pl. 1, fig. 9, p. 253), and uropod 1 has marginal spines on the outer ramus.

Luzon: Laguna Province, summit of Mount Maquiling, altitude 1,060 meters, in the extinct crater, under stones, in dripping mossy forest. The pleopods are described as "not half the size of those of *P. lagunae*, but otherwise normal."

6. **Parorchestia maynei** Chilton.

Parorchestia maynei Chilton: Subantarctic islands of New Zealand, vol. 2, p. 637, figs., 1909. Stephensen: Vid. Meddel. Dansk Naturh. Foren., Copenhagen, vol. 83, p. 349, 1927.

Islands south of New Zealand: Auckland Island, Disappointment Island, Adams Island, under wood, stones, etc., up to 2,000 feet (lower limit not recorded).

7. *Parorchestia parva* Chilton.

Parorchestia parva Chilton: Subantarctic islands of New Zealand, vol. 2, p. 640, figs., 1909. Stephensen: Vid. Meddel. Dansk Naturh. Foren., Copenhagen, vol. 83, p. 350, 1927.

Auckland Island and Norman Inlet: under logs, etc., sometimes together with *P. maynei*.

8. *Parorchestia pusilla* Chevreux.

Parorchestia pusilla Chevreux: Nova Caled. Zool., vol. 2, livr. 1, no. 1, p. 11, figs., 1915.

New Caledonia: in a lake.

9. *Parorchestia sarasini* Chevreux.

Parorchestia sarasini Chevreux: Nova Caled. Zool., vol. 2, livr. 1, no. 1, p. 8, figs., 1915.

New Caledonia: in forest, altitude 700-1,000 meters.

10. *Parorchestia sylvicola* (Dana).

Parorchestia sylvicola (Dana), Stebbing: Das Tierreich, Lief. 21, p. 538, 1906.

Uropod 1 has, as in the majority of the species of the genus, no marginal spines on the outer ramus, but some specimens from New Zealand determined by Stebbing, in the Zoological Museum of Copenhagen, have about 4 marginal spines.

New Zealand: from moist soil in the bottom of the extinct volcano of Taiaimai far from the sea, and perhaps in other parts; Wai-hola, Otago, eating into strawberries in a garden (16, p. 90). Chatham Island, Kermadec Island, Lord Howe Island (19, p. 318). "This is the common terrestrial amphipod of New Zealand" (19, p. 318).

11. *Parorchestia tenuis* Dana.

Parorchestia tenuis Dana, Stebbing: Das Tierreich, Lief. 21, p. 557, 1906. Chilton: Subantarctic islands of New Zealand, vol. 2, p. 642, 1909. Barnard: South African Mus., Ann., vol. 15, pt. 3, p. 226 (literature), 1916. Stebbing: Göteborgs Kungl. Vetensk. Vitt. -Sam. Handl., 4, Följd, vol. 25, no. 1, p. 10, figs., 1922.

New Zealand and Campbell Island; South Africa. On the beach and in a small stream.

CONCLUSIONS

In comparing the Indo-Pacific Talitridae of the genera *Talitrus*, *Orchestia*, *Talorchestia*, and *Parorchestia* (tables 1, 2) with those of the Atlantic one notices that:

1. The genus *Talitrus* has only one littoral (Atlantic) species; all the five other species are terrestrial (24, p. 860), and three of these are Indo-Pacific: *T. alluaudi*, *T. kershawi*, and *T. sylvaticus*.

2. The genus *Orchestia* has about 15 species in the Atlantic and 20 species in the Indo-Pacific area; three of these are common to the two areas (*O. gammarellus*, *O. platensis*, and *O. tucurauna*). Of the species common to the two areas *O. gammarellus* and *O. platensis* are both littoral (on the shore) and terrestrial (see the list of species, above); *O. tucurauna* lives on the shore or in fresh water. Of the remaining 12 Atlantic species almost all live on or quite near the shore, and a few in fresh water (33, pp. 461-468). No species is found having truly terrestrial habits, but three are occasionally found in places far from seashore. They are:

O. chevreuxi de Guerne (36, p. 533), littoral and terrestrial.

O. bottae Milne-Edwards, possibly = *O. cavimana* Heller (36, p. 534, 8, p. 276, figs.), littoral, etc. Terrestrial, Cyprus, altitude 1,255 meters; Holland, in gardens remote from the sea; Italy, Lago di Garda.

O. grillus (Bosc) (36, p. 540; 32, p. 336). Sometimes in almost dry places.

The Indo-Pacific Ocean has 20 species and 2 varieties or forms (+ the three species common to this ocean and the Atlantic). A few of these 23 (25) species are found in fresh water (33, pp. 461-468), and 10 are found very far from the shore up to great heights above sea level (*O. bollonsi*, *O. chiliensis* variety *gracilis*, *O. floresiana*, *O. floresiana* form *monospina*, *O. humicola*, *O. kokuboi*, *O. malayensis*, *O. marquesana*, *O. montana*, and *O. parvispinosa*).

3. The genus *Talorchestia* has 12 species in the Atlantic, probably all living on the seashore. In the Indo-Pacific, the genus has 17 or 18 species, two of which live in fresh or brackish water (*T. gracilis*, *T. martensi*), and three or four are terrestrial (*T. antennulata*, *T. ? diemensis*, *T. kempi*, "semiterrestrial," and *T. rectimana*).

Table 2. Species of Terrestrial Genera Recorded from Polynesia.

	TUAMOTUS	SOCIETY ISLANDS	MARQUESAS	HAWAII	FURTHER DISTRIBUTION
<i>Talitrus alluaudi</i>	×	—	—	—	Madagascar to Tuamotus
<i>Talitrus sylvaticus</i>	—	—	×	×	Tasmania, Australia
<i>Orchestia floresiana</i>	—	—	×	—	Seychelles to the Marquesas
<i>Orchestia floresiana form monospina</i> ..	—	—	×	—	Not found elsewhere
<i>Orchestia gambariensis</i>	(×)	—	—	—	Not found elsewhere
<i>Orchestia marquesana</i>	—	—	×	—	Not found elsewhere
<i>Orchestia pickeringi</i>	×	—	—	×	New South Wales; California
<i>Orchestia platensis</i>	×	—	—	×	Widely distributed
<i>Orchestia rectimana</i>	—	×	—	—	Not found elsewhere
<i>Talorchestia spinipalma</i>	(×)	—	—	—	New Caledonia; Queensland
<i>Parorchestia hawaiiensis</i>	—	—	—	×	Not found elsewhere

(×) = littoral

Indo-Pacific Talitridae

NEW CALEDONIA AND LOYALTY ISLANDS					FURTHER DISTRIBUTION
SOCIETY ISLANDS	TUAMOTUS	MARQUESAS	HAWAII	JUAN FERNANDEZ	WESTERN AMERICA
X					Seychelles, Madagascar (and in hothouses)
	X	X			Scilly Islands, in a garden (<i>T. dorrieni</i> Hunt)
			X	X	
			X		"
				X	
	X				Seychelles
	X				
X					
					Widely distributed
		X			
				X	
	X	X		X	Widely distributed
			X		
				X	
X					
X					
					.
					Only North Pacific: Loo Choo

Table 1. Distribution of

KAMTSCHATKA (K) AND JAPAN (J)	CHINA, GULF OF SIAM, ASSAM	PHILIPPINES (Ph) + CELEBES (C)	SUMATRA, JAVA, BALI, FLORES	AUSTRALIA AND TASMANIA	NEW ZEALAND AND SUBANTARCTIC ISLANDS	ECOLOGICAL CONDITIONS	NEW BRITAIN (B) AND
			×			t.t.	<i>Talitrus alluaudi</i> Chevreux
				×		t.t.	<i>Talitrus kershawi</i> Sayce
				×		t.t.	<i>Talitrus sylvaticus</i> Haswell
					×	t.t.	<i>Orchestia bollonsi</i> Chilton
					×	m.l.	<i>Orchestia chiliensis</i> Milne-Edwards
						t.t.	<i>Orchestia chiliensis</i> variety <i>gracilis</i> Chilton
						l.	<i>Orchestia costaricana</i> Stebbing
						f.w.	<i>Orchestia ditmari</i> Derzhavin
	×		×			m.t.	<i>Orchestia floresiana</i> Max Weber
						t.t.	<i>Orchestia floresiana</i> form <i>monospina</i> Stephensen
						l.	<i>Orchestia gambariensis</i> Chevreux
				?		m.l.	<i>Orchestia gammarellus</i> (Pallas)
						m.t.	<i>Orchestia humicola</i> Martens
						f.w.	<i>Orchestia japonica</i> (Tattersall)
						t.t.	<i>Orchestia kokuboi</i> Uéno
	×					t.t.	<i>Orchestia malayensis</i> (Tattersall)
				×		l.	<i>Orchestia marmorata</i> (Haswell)
						t.t.	<i>Orchestia marquesana</i> Stephensen
					×	l.?	<i>Orchestia miranda</i> Chilton
		C				t.t.	<i>Orchestia montana</i> Max Weber
						l.	<i>Orchestia nitida</i> Dana
			×			t.t.	<i>Orchestia parvispinosa</i> Max Weber
				×		m.t.	<i>Orchestia pickeringi</i> Dana
	×		×			m.l.	<i>Orchestia platensis</i> Kröyer
						t.t.	" <i>Orchestia platensis</i> Kröyer"
						l.	<i>Orchestia selkirki</i> Stebbing
					×	l.	<i>Orchestia serrulata</i> Dana
						l.	<i>Orchestia traskiana</i> Stimpson
					×	l.?	<i>Orchestia tucurauna</i> F. Müller
						t.t.	<i>Talorchestia antennulata</i> Chevreux
				×		t.?	<i>Talorchestia diemensis</i> Haswell
	×					br.w.	<i>Talorchestia gracilis</i> (Dana)
	×					t.	<i>Talorchestia kempi</i> Tattersall
				×		?	<i>Talorchestia limicola</i> Haswell
			×			f.w.	<i>Talorchestia martensi</i> (Max Weber)
				×		l.	<i>Talorchestia novaehollandiae</i> Stebbing
						?	<i>Talorchestia pollicifera</i> (Stimpson)
				×		?	<i>Talorchestia pravidactyla</i> Haswell
				×		l.	<i>Talorchestia quadrimana</i> (Dana)
					×	l.	<i>Talorchestia quoyana</i> (Milne-Edwards)
						t.t.	<i>Talorchestia rectimana</i> (Dana)

4. The genus *Parorchestia* has only one species in the Atlantic (*P. dassanensis* Barnard, 2), but 11 species in the Indo-Pacific. No less than 9 live far from the sea and are terrestrial (or live in fresh water): *P. hawaiiensis*, *P. insularis*, *P. langunae* (fresh water), *P. luzonensis*, *P. maynei*, *P. parva*, *P. pusilla* (fresh water), *P. sarasini*, and *P. sylvicola*.

These four genera together have in the Atlantic (not in the Indo-Pacific) 30 species, of which only 3 (or 4) are found far from the shores; in the Indo-Pacific (not in the Atlantic) about 52 species (+ 2 varieties or forms), about 25 of which are terrestrial. Common to the two oceans are three species, which are all found far from the sea (but also on the seashore).

Thus it is evident that the terrestrial species are characteristic of the Indo-Pacific Ocean. The majority of the terrestrial species live in the forests in the tropical or subtropical zone. One species is known only from hothouses—in Kew Gardens, London, and not found elsewhere, *Talitrus hortulanus* Calman (4)—and one in both hothouses and natural habitats—*Talitrus alluaudi* Chevreux.

Some species of Talitridae with truly terrestrial habits bear the impression of their terrestrial life; Hunt (24, p. 860) has given a record of such characters in the genus *Talitrus*. The most important character is the reduction of the pleopoda, which are quite useless to terrestrial animals. The reduction was, as far as I know, described for the first time in *Talitrus alluaudi* Chevreux (5, p. 389, figs.). Since then, it has been recorded in several other species: *Talitrus kershawii* Sayce, *T. sylvaticus* Haswell, and the other *Talitrus* species (except *T. saltator* Mont. which is a littoral species), *Orchestia floresiana* Max Weber (not very reduced), *O. marquesana* Stephensen, *Talorchestia rectimana* (Dana), *Parorchestia luzonensis* Baker. No doubt the pleopoda are reduced in many more species, but unfortunately the pleopoda of most species are not described. The gills of the anterior pairs of pereopods are rather large, in the female especially so in pereopod 2 (7, p. 3). In some species the eyes have been described as more or less reduced: *Orchestia japonica* (Tattersall) (43), and "*Talorchestia parvispinosa*" (10) = *Orchestia malayensis* (Tattersall) variety *thienemanni* Schellenberg (31); in *Orchestia marquesana* Stephensen, they may be, in several cases, quite colorless (in alcohol). Several of the specimens with colorless eyes

were recorded as having been taken under dead leaves; possibly the want of black pigment is a character due to or connected with digging habits, as presumably the specimens do not live on the very surface of the ground, but deeper down (a similar reduction of the eyes is well known in digging terrestrial Isopoda, especially in the family Trichoniscidae). Several other characters are probably connected with terrestrial habits, but the problem has never been studied very thoroughly except in the genus *Talitrus* (24).

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NEW AND RARE POLYNESIAN CRUSTACEA

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INTRODUCTION

The following account of new and rarely observed decapod crustaceans is a result of collections taken by various field workers in widely separated parts of Polynesia ranging from Hawaii through the equatorial islands to Fiji, including the Lau Archipelago, and Tongatabu.

Interesting records of the study include the occurrence of *Hymenocera elegans* Heller and *Portunus vocans* (A. Milne Edwards) in Hawaiian waters, the latter previously known only from the Atlantic Ocean. A distribution of the little-known genus *Lioxanthodes* into the Pacific Ocean is also reported. Two new genera are created one, *Mesocaris*, to accommodate a cave-dwelling Atyid from Lau and one, *Nullicrinis*, for a Xanthid with atrophied antennae from Christmas Island (North Pacific Ocean).

ORDER DECAPODA

SUBORDER NATANTIA

TRIBE CARIDES

FAMILY LYSMATIDAE

Genus *PROCESSA*

Processa steinii, new species (fig. 1).

Rostrum shorter than the basal segments of the eye-stalk, slightly bent upward, smooth without spines or hairs. Anterior margin of carapace sinuose, a short sharp spine below the orbit, the pterygostomian border rounded. Antennular peduncle exceeding in length the scale of the antenna; basal segment long, narrower in the middle than at the extremities, deeply concave dorsally for the reception of the eyes; the slender flagellum about five times the length of the thicker one. Scale of antenna narrow, slightly overreaching the peduncle.

Endopodite of third maxilliped stout, exceeding in length the peduncle of the antennule by the last two segments. First leg on the right side chelate, smooth and unarmed except for bristles which sparsely fringe the borders; fingers sharp pointed, slightly more than half as long as palm. First leg on the left side non-chelate equal to the cheliped of the opposite side in length but less than one-half its volume and only slightly stouter than the following walking legs, its borders bearing stiff hairs. Second leg on right side very long, carpus with 52 segments; merus which is half as long as carpus and hand together also showing evidences of segmentation. Carpus of second leg on left side with

22 segments. Last three pairs of legs long and slender, the dactylus about one-fifth the length of the propodus; tufts of bristles borne on the dactylus, propodus and carpus.

Telson becoming abruptly narrowed in distal third; bearing two pairs of spines on dorsal border and numerous stout hairs; posterior border bearing a

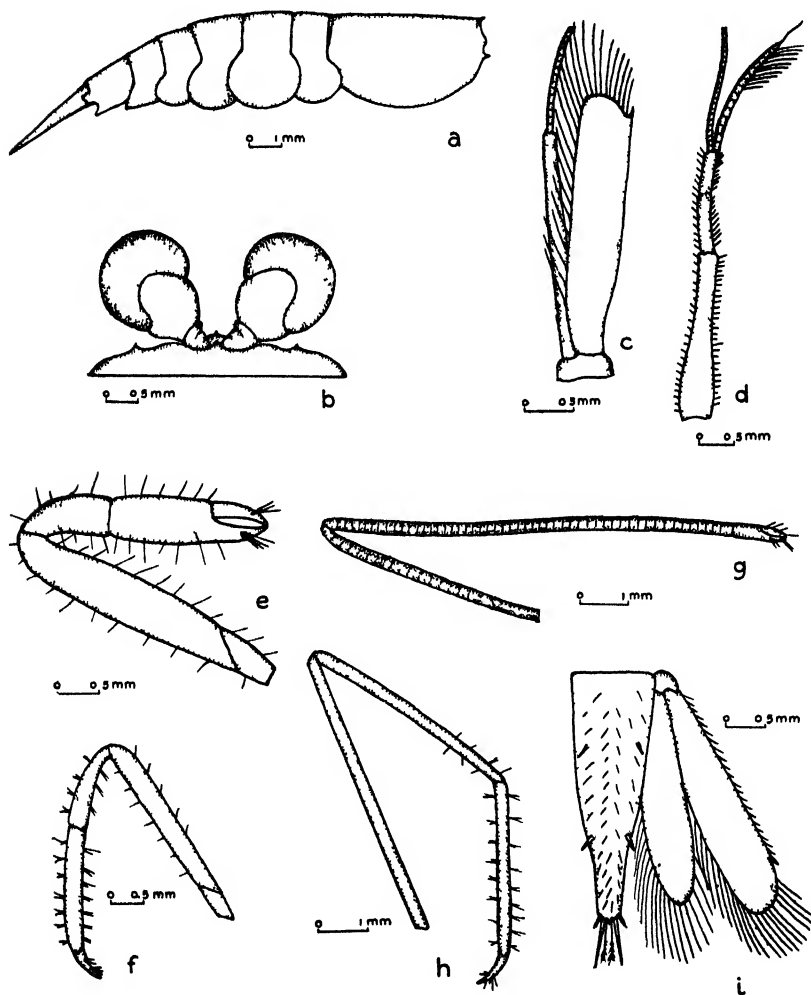


FIGURE 1.—*Processa steinii*, new species: a, lateral view of carapace and abdomen; b, front border of carapace and the eyes; c, peduncle and scale of antenna; d, antennule; e, first leg on right side; f, first leg on left side; g, second leg on right side; h, third leg; i, telson and uropod.

short median spine and one at each lateral angle and a much longer intermediate one on each side; a median pair of feathered setae are slightly shorter than the intermediate spines. Uropods narrow, the exopodites longer than the telson, margins fringed with hairs.

Color of type specimen preserved in alcohol white, the pigmented areas of the eyes black.

Type specimen a male, total length from tip of rostrum to posterior extremity of telson 17 mm. Type locality a shoal water reef of Maui, in a coral head. Bishop Museum collections no. 3918.

Three species of the genus *Processa* have previously been recorded from Hawaii (4, 8, 9).¹ In one of these, *P. processa* (Bate), a widely distributed form, the rostrum is as long as the eyes and the carpus of the second leg on the right side has about 65 segments. In the species *P. hawaiiensis* (Dana) the rostrum is shorter than the eyes and the carpus of the second leg on each side has 11 segments. The third species, *P. paucirostris* Edmondson, described from the island of Maui, has a straight rostrum shorter than the eyes and the carpus of the second leg on the right side has 18 segments.

This new species, *Processa steinii*, is named in honor of Mr. Harold Stein, an enthusiastic student of natural history who collected the specimen and presented it to the Bishop Museum. In length of rostrum *P. steinii* is close to *P. paucirostris* but differs from that species in the antennular peduncle, cheliped, carpus of the second leg on the right side and in the telson.

Other members of the genus having Indo-Pacific or general distribution and which might be expected to range into the central Pacific area include *Processa japonica* (de Haan), *Processa canaliculata* Leach, and *Processa jacobsoni* de Man. In each of these the rostrum is at least one-half as long as the eye-stalks.

FAMILY PONTONIIDAE

Genus PONTONIA

Up to the present time but one species of *Pontonia* has been reported from Hawaiian waters. This small form, *Pontonia quadratophthalma* Balss (3), was described from the northwest shore of Australia. It is about 10 mm long and may be recognized by the quadrate form of the eye-stalks. About Hawaii it is abundant in tubular sponges attached to the under surface of stones near shore. Several other species of the genus have been recorded from the Indo-

¹ Numbers in parentheses refer to Literature Cited, pp. 37-38.

Pacific area including such widely separated localities as the Seychelles, South Australia, the coasts of India and Japan.

In a small collection of marine crustaceans sent to the Bishop Museum during July 1934 from Midway Island, leeward Hawaii, were three specimens which I have assigned to the genus *Pontonia* and which apparently represent a new species. The species is a thick bodied form slightly depressed having the general appearance of a member of the genus *Conchodytes* but excluded from it by the absence of a basal protuberance on the dactylus of the walking legs. From the genus *Coralliocaris* it is separated by the character of the rostrum, external maxillipeds and dactyli of the walking legs.

Previously recorded species of *Pontonia*, where information is available, are known to be associated with clams, ascidians and sponges. The association of the new species from Midway is unknown.

***Pontonia medipacifica*, new species (fig. 2).**

Body of type specimen heavy, somewhat depressed. Rostrum short, reaching slightly beyond the base of the first segment of the antennular peduncle, without teeth, broad at the base, sharp at the apex, keeled above and below; an oval depressed area on either side of the base of the rostrum. Front margin of carapace bearing a small antennal spine and marked by a slight furrow extending posteriorly from about the middle of the orbit; antero-ventral border rounded.

Eye-stalk bulbous with cornea narrower than the stalk, no ocular spot present. Antennular peduncle a little shorter than the scale of the antenna; first segment broadly expanded, its median tooth extending to the middle of the segment and the distal tooth to the middle of the second segment which is longer than broad; third segment broader than long. No visible subdivision of the thicker branch of the antennular flagellum, but it bears long hairs in its middle section. Scale of antenna slightly longer than the peduncle of the antennule, its outer margin straight and bearing a sharp spine at its distal extremity; flagellum long, its peduncle shorter than the scale. Mandible without palp; the curved incisor branch terminating in four sharp teeth; the mandibular process shorter and thicker than the incisor branch. Third maxilliped with the two distal segments narrower than the preceding one and their surface plane placed at an angle with it; exopodite slender; all segments fringed with hairs.

First pair of chelipeds slender, extending beyond the scale of the antenna by the length of the manus and half the length of the carpus; merus and carpus subequal, manus slightly shorter than carpus; fingers sharp pointed bearing hairs at the tips; dactylus subequal in length with palm. Second chelipeds larger than first, similar to each other in form and size; merus and carpus cylindrical, smooth, the former slightly longer than the latter; palm and fingers slightly compressed; dactylus, which is slightly shorter than palm, bears a tooth near the

proximal end of the cutting edge; immovable finger with two teeth on basal half of cutting edge; fingers crossed when closed.

Walking legs slender, cylindrical; propodus five times the length of the dactylus, which is oval, biunguiculate, without basal protuberance and without

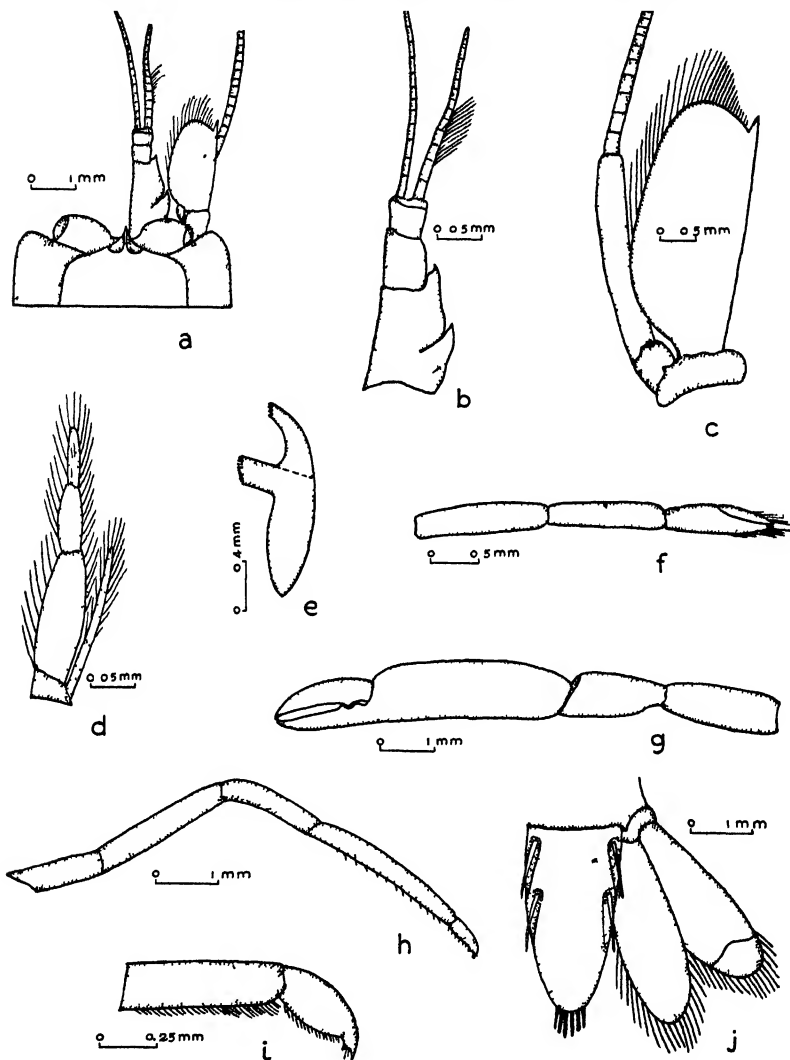


FIGURE 2.—*Pontoma medipacifica*, new species: a, dorsal view of anterior margin of carapace with appendages; b, antennule; c, antenna; d, third maxilliped; e, mandible; f, first cheliped; g, second cheliped; h, first walking leg; i, dactylus and part of propodus of walking leg; j, telson and uropod.

spines except the accessory tooth near the tip; lower border of dactylus and of propodus fringed with hairs.

Telson slightly more than two times as long as broad at base and bears two pairs of large movable spines on the dorsal surface, both pairs on the basal half, the first pair near the suture with the sixth abdominal segment. Of the three pairs of terminal spines of telson the median ones are the longest, the intermediate next in length and the lateral ones the shortest. The intermediate spines are thicker and blunter than the others. Outer branch of the uropod is shorter than the inner and no tooth is borne on its lateral border.

Apparent color of recently preserved specimens bright red with a deeper red spot in the middle of the dorsal surface of the carapace. Under high magnification dots of pale yellow or white are visible on the larger chelipeds. The red color gradually fades in alcohol.

Type specimen an ovigerous female; length from tip of rostrum to extremity of telson 21 mm. Type locality, Midway Island, in shallow water, association unknown. Bishop Museum collections no. 3845.

This new species bears considerable likeness to a *Conchodytes* in the form of the body and the toothless rostrum, but I consider it a representative of the genus *Pontonia* by reason of the character of the dactyli of the walking legs. From the other recorded Hawaiian species *Pontonia quadratophthalma* (3), it is easily distinguished by the form of the eyes and chelipeds as well as by size. It is separated from *Pontonia minuta* Baker (1), type locality South Australia, by the short rostrum. In the Australian species the rostrum outreaches the antennular peduncle.

In form of rostrum *Pontonia brevirostris* Miers, described from the Seychelles, closely resembles the species under consideration but in the Indian Ocean form the fingers of the large cheliped lack teeth and the dactyli of the walking legs are styliform. In *Pontonia ascidicola* Borradaile (5), recorded from New Britain, the rostrum reaches the middle of the first antennular segment and the dactyli of the walking legs bear numerous spines. Two species described by Kemp, *Pontonia oki* (16, p. 261, figs. 89-92) from the coast of Burma and *Pontonia anachoreta* (16, p. 264, figs. 93-95) from off Madras, differ from the Midway Island form in that both bear numerous spines on the dactyli of the walking legs. The only *Pontonia* known from the west coast of America, *Pontonia californiensis* Rathbun (23), was dredged near Santa Cruz Island in 30 fathoms of water. In this species the rostrum is very long, about one-third the length of the carapace.

Genus PERICLIMENES

There are a number of well known genera of marine shrimps of the tribe Carides each of which includes one or more species habitually associated with other animals such as sponges, coelenterates, echinoderms, mollusks or ascidians. Many of these small commensal decapods are brightly colored harmonizing with the color of the animal on which they live. Taxonomists variously assign them to the subfamily *Pontoniinae*, family *Palaemonidae* or families *Pontoniidae* and *Palaemonidae*.

In Hawaii certain associations of this nature are well known and of common observation, others are rarely seen. The species *Harpilius depressus* Stimpson is a typical commensal on living corals of the genus *Pocillopora*. A small and locally abundant form, *Pontonia quadratophthalmia* Balss, is found concealed in tubular sponges on the under surface of stones in shallow water. A larger representative of the group, *Conchodytes meleagrinae* Peters, lives within the mantle of the large pearl oyster, and *Coralliocaris mammillata* Edmondson was discovered on the spines of the large red sea urchin, *Heterocentrotus mammillatus* (Linnaeus). Other species of *Harpilius*, *Coralliocaris*, *Palaemonella* and *Periclimenes* have been recorded from Hawaiian waters but their commensal relationship with other local organisms has not been observed.

Recently a brightly colored and apparently undescribed form was found living on the reddish-brown starfish, *Linckia multifora* (Lamarck), abundant in Kaneohe Bay, Oahu. It is here described as a new species of *Periclimenes*.

The genus *Periclimenes*, as defined by Kemp (16, pp. 118-288) includes three subgenera and more than 60 species about a dozen of which are commensals on coelenterates and echinoderms. Although it is not easy to point out specific generic characters where many variable forms are concerned, the genus *Periclimenes* may be recognized by the following positive and negative features: Carapace not depressed; rostrum laterally compressed and bearing teeth; no mandibular palp and no basal protuberance on the dactylus of the last three pairs of legs; carpus of the first leg unsegmented and all the maxillipeds bearing exopods.

Periclimenes bicolor, new species (fig. 3).

Body slender, antennal and hepatic spines present but no supraorbital spine. Rostrum laterally compressed, deep, approximately as long as carapace; upper border bearing 15 teeth, lower border entire. Antennular peduncle stout, basal spine not reaching to the extremity of the first segment; basal segment bearing 3 stout teeth on the distal free border; outer thicker branch of antennule shorter than the inner branch and bearing stout hairs but showing no appearance of being bifid. Antennal scale extending beyond the distal extremity of antennular peduncle, the tooth on its outer border being on a level with the tip of the rostrum; scale fringed with long hairs on the inner and distal borders.

Incisor branch of mandible terminating in 4 teeth the medial one small; molar branch as long as incisor, its blunt end bearing short stiff hairs. Eye-stalks large, quadrangular, slightly compressed.

First pair of legs chelate, slender, smooth, reaching to the tip of rostrum when extended forward; manus and carpus equal in length, each slightly shorter than merus; fingers equal to palm in length, broadly spatulate with the inner border of each pectinate. Second pair of legs chelate, slender, smooth, similar in form but, in the type specimen, unequal in size the right one being the longer and larger, reaching to the tip of the scale of the antenna when extended forward; left leg reaching the tip of the rostrum. Right of second pair of legs with segments cylindrical, unarmed; manus more than four times the length of the carpus and nearly three times the length of the merus; palm a little more than three and one-half times the length of the fingers which equal the length of the carpus. Dactylus with a sharp cutting edge but without teeth; pollex with three teeth on the cutting edge, the two proximal ones being small.

The three posterior pairs of legs long slender and unarmed except for the dactylus which is provided with an accessory tooth; propodus seven times the length of the dactylus and twice the length of the carpus.

Telson typical in form for members of the genus, with two pairs of dorsal spines and three pairs of terminal ones, the lateral ones being the shortest and the adjoining ones the longest. Uropods extending slightly beyond the tip of the telson.

Living type specimen sharply differentiated into two color areas, hence the specific name *bicolor*. Below a horizontal line on either side extending from the tip of the rostrum backward through the carapace gradually sloping to the lower border of the sixth abdominal segment the surface is heavily pigmented, the ground color being violet-red with minute white spots thickly interspersed. Above this line, including the upper half of the rostrum, carapace and increasingly larger amounts of the abdominal segments, the surface is whitish interspersed with minute dots appearing under high magnification whiter than the general surface background. The telson, uropods, legs (except basal segments), flagella of antennules and antenna are transparent. Eye-stalks, peduncles of antennule, scale of antenna are pigmented as the lower half of the carapace except the ground color of these appendages is white interspersed with minute spots of violet-red. From a dorsal view the animal presents a broad longitudinal band of white bordered on either side by red.

Type specimen a female, length from tip of rostrum to distal extremity of telson 11 mm. Type locality, Kaneohe Bay, Oahu, on

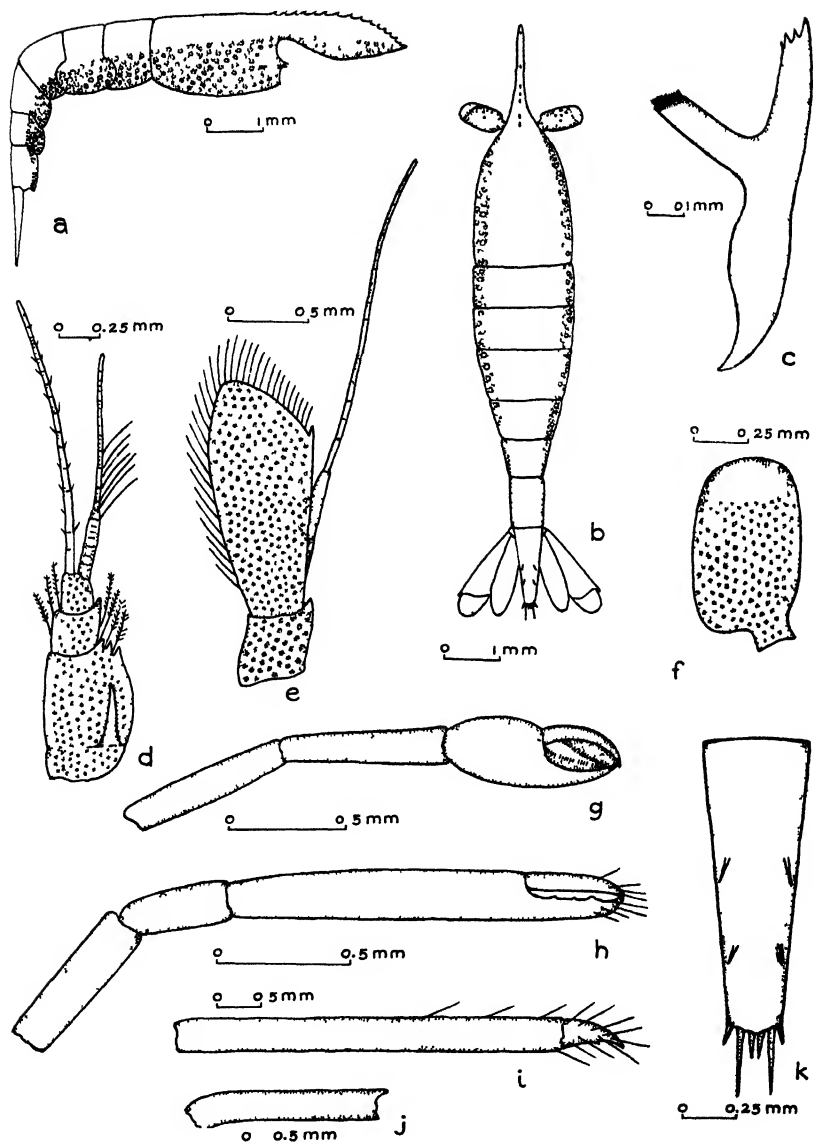


FIGURE 3.—*Perichlmenes bicolor*, new species: a, lateral view of rostrum, carapace and abdomen, lower portion heavily pigmented; b, dorsal view of the same; c, mandible, greatly enlarged; d, antennule; e, antenna; f, eye-stalk; g, merus, carpus, and manus of first cheliped; h, carpus and manus of second cheliped; i, propodus and dactylus of third leg; j, carpus of the same; k, telson, dorsal view.

Linckia multifora in shallow water. Bishop Museum collections no. 3756.

This form, which differs from the numerous species of the genus previously described both in structural features and color, is near *Periclimenes soror* Nobili (19) and *Periclimenes noverca* Kemp (16, p. 162, figs. 28-30) in the pectinate margin of the spatulate chela of the first leg. It differs from both, however, in the form and armament of the rostrum and in the relatively shorter fingers of the second leg compared with the length of the palm. The form of the rostrum including its extreme depth in side view and the absence of teeth on the lower border resembles that of *Periclimenes rex* Kemp but the number and disposition of the teeth on the upper border of the rostrum, as well as structural features of the chelipeds and other appendages, separate that species from the Hawaiian form.

It is pointed out by Kemp (16, p. 136) that the extent to which the outer antennular flagellum is cleft varies greatly within this genus, ranging from species having a deeply cleft flagellum to those in which there is scarcely a division at all. The new Hawaiian species is unique in that there is no perceptible cleft of the outer branch of the antennular flagellum.

From collections made by the Albatross Rathbun (20, p. 921) described 2 species, *Periclimenes pusillus* from the surface off the south coast of Oahu and *Periclimenes* sp. (damaged specimens) from the south coast of Molokai, 23 to 24 fathoms, and near Kauai, 68 to 179 fathoms. These species are assumed to be free-living, without commensal habits, and neither of them closely resembles the form from Kaneohe Bay here described.

FAMILY ATYIDAE

Among a collection of crustaceans taken in the southern Lau Islands, Fiji, by Harry S. Ladd during 1934 and sent to the Bishop Museum were two lots, one from a cave containing brackish water on the island of Namuka and one from a salty lake on the island of Wangava. On examination the specimens from the two sources were found to be identical, representing a very primitive type of Atyid with well-developed exopodites on all the legs and presenting other characteristics which would seem to require the establishment of a new genus for their accommodation.

Genus **MESOCARIS**, new genus

Carapace without supraorbital but with suborbital and pterygostomial spines. Rostrum stout, without spines. Chelae with tufts of hairs at tips. Well-developed exopodites on all legs. Epipodites on third maxillipeds and all legs but the last pair. A single uropodal spine. Gills seven pairs. Eye-stalks subnormal with a small amount of pigment.

Mesocaris lauensis, new species (fig. 4).

Body stout, not depressed. Carapace with well-developed suborbital and pterygostomial spines. Rostrum triangular when viewed from above, reaching beyond the middle of the second segment of the antennal peduncle, without spines, upper border rounded, lower border sharp. Eye-stalks short and broad, slightly flattened, the inner angle bluntly pointed, the pigment confined to a small area at the outer angle and directed laterally.

Basal segment of antennular peduncle a little shorter than the combined length of the other two, its spine reaching beyond its distal extremity; flagellum very long. Scale of antenna oval, overreaching the peduncle of the antennule, a small spine on the lateral border; flagellum approximately ten times the length of the carapace and a little longer than the flagella of the antennule. Mandible with a strong, curved incisor process terminating in a number of small teeth; molar process longer than incisor, the hollowed out tip rimmed with chitin. Exopodite of second maxilla short, rounded and fringed with short hairs. Third maxilliped narrow, foot-like, a long slender spine on the basal segment. First cheliped shorter than second, merus and carpus subequal, ischium shorter than merus, the distal extremity of the carpus deeply excavated; exopodite overreaching the distal end of the merus. Carpus of second cheliped longer than merus also deeply excavated at distal end; ischium and merus subequal in length; exopodite reaching the distal extremity of the merus.

Walking legs slender, approximately of equal length but differing in proportionate length of segments. In first walking leg combined length of ischium and merus greater than in last leg but both propodus and dactylus of last leg exceed in length corresponding segments of first leg. Exopodite of last leg relatively longer than in the first leg in proportion to the length of combined ischium and merus. Dactyli long, slightly curved, a row of spinules on the posterior border, the last spinule being stout giving the dactylus a biunguiculate appearance. Several spines on the lower border of the ischium and merus of the first walking leg, a lesser number on the last leg. Epipodites on the basal segment of the third maxilliped and all the legs except the last. In broad view the epipodite presents a constriction near the free end, in edge view it is seen to terminate in a strong hook.

Telson slightly longer than the sixth segment of the abdomen, its distal border bearing, in addition to a short spine at each angle, 6 longer ones, the lateral pair exceeding the others in length. The exopodite of the uropod is longer and broader than the endopodite and bears a single uropodal spine on its lateral border. The branchial system includes 7 pairs of gills the one at the base of the second maxilliped being very small and those at the base of the third maxilliped and last leg are smaller than the intervening ones.

Color bright red in living state. Gradually fading to white in alcohol.

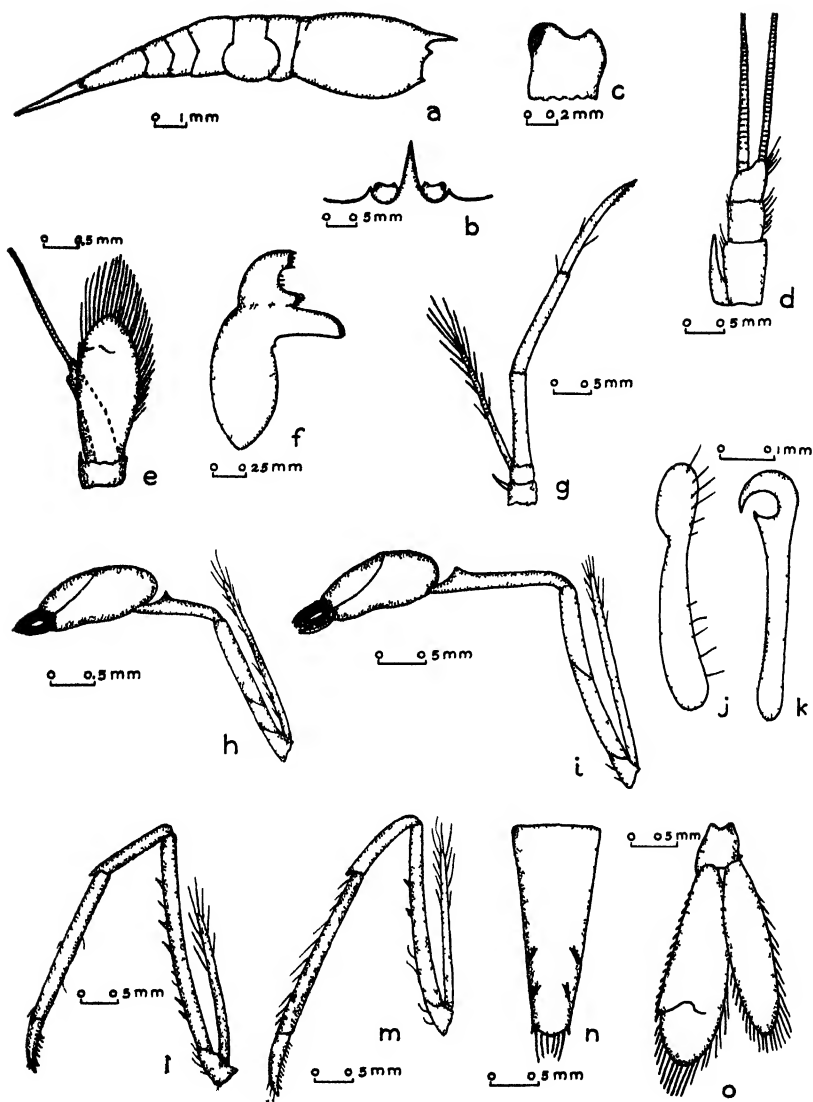


FIGURE 4.—*Mesocaris lauensis*, new species: a, side view of carapace and abdomen; b, anterior border of carapace with rostrum and eyes; c, eye-stalk with remnant of pigment; d, antennule; e, antenna, with scale; f, mandible; g, third maxilliped; h, first cheliped; i, second cheliped; j, broad view of epipodite; k, edge view of epipodite; l, first walking leg; m, last walking leg; n, telson; o, uropod.

Type specimen a female, total length from tip of rostrum to posterior end of telson 15.5 mm. Type locality a cave containing brackish water, island of Namuka, Lau Islands, Fiji, Bishop Museum collections no. 3898.

Although more than a dozen species of decapod crustaceans are known to have become adapted to life in caverns, grottoes and other subterranean habitations few representatives of the family Atyidae have been reported as showing adaptations to a cavernicolous existence in the form of atrophied eyes. In 1853 the first of these, *Troglocaris schmidtii* was described by Dormitzer, from the caves of Carniola, recorded by Bouvier (6) and in May 1901 Hay recorded a blind Atyid, *Palaemonias ganteri* (13), from the Mammoth Cave of Kentucky.

In a recent reexamination of *Palaemonias* Fage (11) calls attention to its similarity to *Troglocaris* in that the exopodite of the second maxilla is short, rounded and lacks a brush of long hairs typical of most other members of the family. Another character common to these two forms is the excavation of the distal ends of the carpi of both pairs of chelipeds. In *Troglocaris*, however, there are 8 pairs of gills and the exopodites of the last pair of walking legs have disappeared. In *Palaemonias* the gills are reduced to 4 and a rudiment on each side but all walking legs retain exopodites although those of the last pair are rudimentary. As Fage points out *Palaemonias* occupies a peculiar position among the Atyidae in that it shows a marked degree of specialization in the gills while it retains some of the most primitive characters of the family.

In addition to the type specimen 11 cotypes were taken from the Namuka cave and 14 other specimens from the Wangava salty lake. In these prawns the adaptation to a subterranean life is expressed by a modification of the eye-stalk and a reduction in the amount of ocular pigment. The unusual length of the flagella is probably correlated with diminished vision. In general form and reduction of pigment the eye-stalk of this Atyid closely resembles that of *Palaemon cavernicola* described by Kemp (15) from the Siju Cave, Assam. According to Kemp the Assam species was the only decapod crustacean showing such adaptations to a subterranean existence then known (1924) in the Orient. The discovery of the Lau species seems to be the first such record for the islands of the Pacific Ocean.

Red color is not an unusual one among animals living under conditions of weak light. Even in cave-dwelling crustaceans which appear quite transparent or translucent a considerable amount of scattered red pigment may be found, as both Kemp and Rathbun report. There are other species of Atyidae inhabiting brackish water in which the red color persists. In Hawaii a small form tentatively determined by Rathbun as *Caridina brevisrostris* (20) is bright crimson in color when living. It inhabits caverns in the coral plains near the seashore and has been found in old wells close to the sea. Both sea water and fresh water are fatal to the species, which requires an intermediate degree of salinity.

In character of the exopodite of the second maxilla this form from Lau resembles *Troglocaris* and *Palaemonias* but presents more primitive characters than either in the well-developed exopodites on all the legs. In *Mesocaris* a slight amount of ocular pigment has been retained while in *Troglocaris* and *Palaemonias* it has entirely disappeared, which may possibly be correlated with a longer or more perfect subterranean existence.

Concerning the habitat of the prawns on the island of Namuka Dr. H. S. Ladd in a personal communication has the following to say:

Numbu (deep) cave lies almost in the geographical center of the island of Namuka. As mapped the cave lies 1550 feet north of the Mbulis house in Namuka's single village. The cave is 65 feet high, the lowest 10 feet being filled with brackish water. The pool is 30 by 50 feet, its surface lying at sea level. The temperature of the water at the surface is 23.1 degrees Centigrade. In this pool the red prawns appear by the hundreds.

While it is obvious that a cave such as that of the island of Namuka may represent conditions conducive of diminution of eyesight among its inhabitants it is not so clear why these crustaceans living in an exposed lake as that of the island of Wangava should equally show reduction of ocular pigment. This salt lake is, according to a personal communication from Dr. Ladd, of considerable size and while somewhat remote from the sea is connected with it by subterranean channels. It is probable that underground caverns and passages connected with the lake have for a long period of time offered habitats encouraging adaptation to a cavernicolous existence.

The origin of the brackish water Atyid of Lau is problematic. At least two species of *Atya* and numerous ones of *Caridina* are

present in the fresh waters of the larger islands of Fiji but the very primitive Atyidae do not seem to include this archipelago within their range. Among previously known Atyidae having exopodites on all the legs only representatives of the genus *Paratya* (*Xiphocaridina*) have extended themselves, in any degree, into the southwest Pacific area. This genus has been recorded from Japan, Upper Assam, India, Australia, New Zealand, Chatham Islands, Lord Howe Island, and Norfolk Island. If the divergence of the Lau Atyid was from some *Paratya*-like form it came about by a modification of external features such as rostrum, spines of carapace, carpi of chelipeds, etc., rather than internal branchial changes, as the number of gills is identical in the two genera.

Key to the genera of Atyidae with exopodites on all legs

- No tufts of hairs at tips of chelae and no excavation of carpi of chelipeds **Xiphocaris**
- Tufts of hairs at tips of chelae and carpi of at least one pair of chelipeds excavated.
- Supraorbital spines present.
 - Excavation of carpi of first pair of chelipeds only; eyes normal **Paratya** (*Xiphocaridina*)
 - Excavation of carpi of both pairs of chelipeds; eyes without pigment **Palaemonias**
- Supraorbital spines absent; carpi of both pairs of chelipeds excavated; eyes with little pigment **Mesocaris**, new genus

FAMILY GNATHOPHYLLIDAE

Genus HYMENOCERA

Hymenocera elegans Heller.

The first observation of this remarkable crustacean in Hawaii was in August 1934 when a specimen 32 mm long was collected on a shallow reef in Kaneohe Bay, Oahu, among the branches of a *Porites* coral head. Since sufficient descriptions of the structural features have been given by several authors it will suffice here to say that the species may be recognized by the winglike expansions of the hand of the cheliped, flagellum of the antennule and the third maxilliped.

Apparently few investigators, however, have seen the species alive as scant mention has been made of the unusual color markings exhibited, rivaling or even exceeding in vividness that of the

"bandana shrimp", *Stenopus hispidus*. In *Stenopus* the color pattern consists of red bands encircling the body and appendages while in *Hymenocera* it includes bands, saddle-patches and ocular spots involving a diversity of colors.

Gravier (12) in 1921 described somewhat in detail the coloration of a living specimen of *Hymenocera* taken off the east coast of Africa. This observer noted the spots and other color markings to consist chiefly of tints of yellow, blue, salmon and brown. Since there seems to be considerable variation in the color of this species it would appear worth while to record the color of the Hawaiian specimen as it was when alive.

Color Markings of *Hymenocera elegans* from Oahu

Carapace. A band of reddish-purple from orbit to antero-ventral angle, 1 mm wide at lower end, narrower above. Saddle-patch of the same color at the base of the first rostral tooth extending one-fourth the distance toward the ventral border. An irregular patch of this color near the postero-ventral margin.

Abdomen. A reddish-purple patch on either side of the mid-dorsal line beginning at the anterior border of the first segment becoming narrower as it extends ventrally and posteriorly over the second segment. The color is deeper toward the ventral margin of this area. A transversely elongated saddle-patch of reddish-purple with dull orange center extending over the mid-dorsal line of the second segment. A circular reddish-purple spot on the third segment in the mid-dorsal line on the summit of the angle of the abdomen. On the fourth segment a saddle-patch of the same color, narrower in the midline, extends half way down on the sides of the segment. Fifth segment without color markings. Sixth segment with a dorsal and a ventral reddish-purple patch, the two almost meeting laterally. Parts of the ventral margins of the first four segments are also marked by a similar color. Telson without color markings.

Appendages. Lateral one third of long eye-stalks reddish-purple, remainder without color. Basal segment of antennules and scale of antenna marked by transverse, narrow, irregular bands of golden brown color. Expanded flagellum of antennule with three reddish-purple spots toward the distal extremity. Merus of cheliped with two broad bands of the same color. Carpus with a faint ring of color about the proximal end and on ventral surface. The expanded wing-like propodus marked by several splotches of purple with lighter centers. A patch of purple saddles over the dorsal border of the palm near the middle. The fingers are banded with purple at the base and tips. The winglike expansions of the third maxilliped are marked by circular rings of reddish-purple.

Segments of the walking legs, except the dactylus, are marked by a broad band of reddish-purple. The exopodite of the uropod is colored near the basal end like the scale of the antenna and the endopodite has a large circular spot of purple at the distal extremity.

SUBORDER REPTANTIA

TRIBE BRACHYURA

FAMILY LEUCOSIIDAE

Genus ACTAEOMORPHA

The family Leucosiidae includes small crabs the carapace of which is roughened by elevations and depressions exhibiting some degree of protective resemblance to stones, bits of coral or shells in their natural environment.

In 1878 Miers established the genus *Actaeomorpha* to accommodate the species *Actaeomorpha erosa* described by him at that time. The genus differs from a closely allied one, *Oreophorus* (Tlos), in that the walking legs are not concealed in flexion by an extension of the postero-lateral margins of the carapace and the segments of the abdomen are distinct.

The species *Actaeomorpha erosa* was described from Port Curtis, Australia, and has since been reported from such widely separated localities as Mauritius, Bay of Durban, South Africa, the Kermadec Islands and Hawaii. The success of this minute crab may be due, in part at least, to the character of the carapace and legs which are deeply pitted resulting in a close similarity to an eroded pebble or limestone fragment. In Hawaii the species has frequently been taken at Black Point, Oahu, where it is found concealed in crevices of dead coral blocks. It has also been collected on Waikiki reef. Locally the species has been observed only in shoal water near shore. The type specimen was from a depth of 7 fathoms and the South African record from 24 fathoms.

Early in 1934 a small crab was collected at Black Point, Oahu, associated with *Actaeomorpha erosa* which, while obviously of the same genus cannot be confused with that species. A specimen now recognized to be of similar form was secured at Kure Island in 1923 by the Tanager Expedition and one at Christmas Island, North Pacific Ocean, in 1924 by the Whippoorwill Expedition. Both these specimens were immature but present the same general features as the type specimen described here under the name *Actaeomorpha punctata*.

Key to known species of Actaeomorpha

- A Carapace deeply pitted and eroded.....**Ac. erosa** Miers
Actaeomorpha erosa Miers, Linn. Soc., Jour., vol. 13, p. 183, fig. 1-6, 1878, Port Curtis, Australia, 1 specimen, 7 fathoms; Chilton, New Zealand Inst., Trans. and Proc., vol. 43, p. 555, 1910, Kermadec Islands, several specimens on coral; Bouvier, Bull. Sc. de la France et de la Belgique (7), p. 48, 1915, Mauritius; Stebbing, Ann. Durban Mus., vol. 2, p. 273, pl. 32, 1920, Bay of Durban, South Africa, 1 specimen, 24 fathoms; Edmondson, B. P. Bishop Mus., Special Publ. 22, p. 234, fig. 143 b, 1933, Oahu, several specimens, shoal water.
- AA Carapace not deeply pitted and eroded.
- B A groove encircling the carapace parallel with the lateral border; areas defined by furrows.
- a The groove encircling the carapace separated from the border by a wide margin; second of four rounded lobes of the lateral border bifid**Ac. sculpta** (Haswell)
Lithadia sculpta Haswell, Linn. Soc. N. S. W., vol. 4, p. 57, pl. 6, fig. 5, 1879, Fitzroy Islands; Laurie, Ceylon Pearl Oyster Report, vol. 5, p. 359, 1906, Arafura Sea, 1 specimen, Eastern Seas, 1 specimen.
- aa The groove encircling the carapace close to the border; none of the lobes of the lateral border bifid.
- b Furrows extending forward from cardiac region parallel and terminating about the middle of the carapace.
- c The groove encircling the carapace not angular in its course.....**Ac. aglypha** (Laurie)
Lithadia sculpta variety *aglypha* Laurie, Ceylon Pearl Oyster Report, vol. 5, p. 358, fig. 2, 1906, Gulf of Manaar, 1 specimen, coral reefs.
- cc The groove encircling the carapace angular in its course.....**Ac. aglypha** variety *angulata* Ihle
Actaeomorpha aglypha variety *angulata* Ihle, Siboga Expedition Mono., 39 b2, p. 209, fig. 120, 1918, Banda, 9-36 meters, 1 specimen.
- bb Furrows extending forward from cardiac region not parallel and not terminating about the middle of the carapace.
- d Four angular lobes on the lateral margin; regions separated by deep cut grooves.....**Ac. morum** Alcock
Actaeomorpha morum Alcock, Asiatic Soc. Bengal, Jour., vol. 65, p. 172, 1896, off Ganjam Coast, 28-30 fathoms, 2 specimens.
- dd Three angular lobes on the lateral margin; regions separated by shallow grooves**Ac. lapillulus** Alcock
Actaeomorpha lapillulus Alcock, Asiatic Soc. Bengal, Jour., vol. 65, p. 172, 1896, off Ceylon, 32-34 fathoms, 4 specimens.
- BB No groove encircling the carapace parallel with the lateral margin; areas not defined by furrows.....**Ac. punctata**, new species

Actaeomorpha punctata, new species (pl. 1, A; fig. 5).

Carapace oval, slightly broader than long; surface irregular, marked by elevations and depressions but not distinctly grooved. Front protruding, a deep notch separating the two prominent lobes which terminate posteriorly in dome-

like elevations. Gastric area depressed and flattened; cardiac area slightly elevated; branchial region prominent; hepatic area, posterior and lateral to the orbit greatly depressed. Entire dorsal surface closely set with smooth and slightly elevated tubercles of nearly uniform size. Under high magnification the tubercles are seen to be surrounded by minute punctae hence the specific name *punctata*. The tubercles are somewhat more prominent about the margins of the carapace and over its posterior half. Lateral border nearly entire; a minute tubercle marking the junction of the anterior and posterior lateral borders and two additional, inconspicuous ones on the posterior lateral border. The lateral border is rimmed by tubercles like those of the surface of the carapace but more prominent, there being a double row along the postero-lateral border. Orbits small and almost concealed in a dorsal view by the prominent frontal lobes.

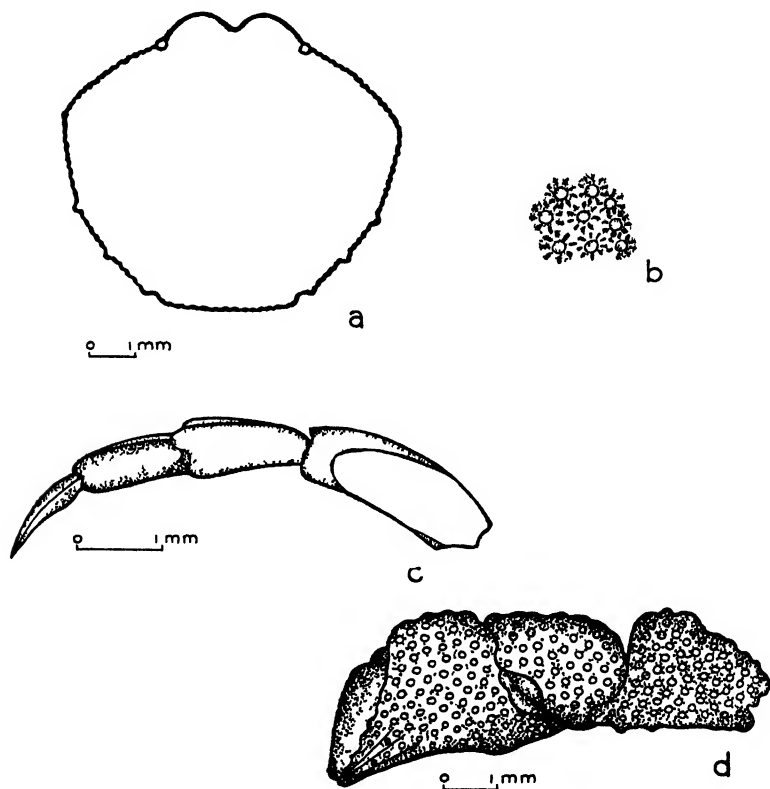


FIGURE 5.—*Actacomorpha punctata*, new species: a, outline of carapace; b, detail of surface ornamentation, greatly enlarged; c, third walking leg; d, left cheliped.

Under surface of the carapace smoother than the upper surface. Buccal cavity completely closed by the stout external maxillipeds; exopodite of outer maxillipeds slightly curved, bearing a short flagellum. Basal segments of antennae fused with the orbit and antennules folded obliquely as in other members of the genus.

Chelipeds short and stout; surface of arm, outer surface of wrist and of hand covered with tubercles like those of the carapace and punctate in the same manner. Slightly more prominent tubercles form irregularities on the lower border of the arm and the upper border of the palm. Fingers stout, especially the immovable one, the sharp tips crossed when closed; the cutting edge of each bearing 5 blunt teeth. The walking legs are similar in form and surface ornamentation. Surfaces of legs smooth, finely punctate but tubercles are indistinct except on the upper borders. Upper border of carpus and propodus grooved longitudinally, the carpus provided with two grooves, the propodus with one. Dactylus long, sharp, longitudinally grooved on the surface.

Last segment of abdomen (male specimen) triangular, longer than broad, smooth except at the base. Other segments bearing large, rounded transverse ridges.

Type specimen a male, length of carapace 7 mm, breadth 7.5 mm. Type locality, Black Point, Oahu, in a crevice in a dead coral block, near shore. Bishop Museum collections no. 3738. Other specimens in the Bishop Museum are from Kure Island and Christmas Island, North Pacific Ocean.

Up to the present time apparently 5 species and 1 variety of the genus have been recorded in the literature. The new Hawaiian species is clearly distinct from each of the previously described forms. From the widely distributed species, *A. erosa*, it is distinguished by the absence of deep pits in the carapace and appendages. From the other recorded forms the one here described differs in the absence of a groove encircling the carapace, of clear cut furrows bounding the areas and of distinctly lobulated lateral borders.

FAMILY PORTUNIDAE

Genus *CAPHYRA*

Among the swimming crabs, family Portunidae, subfamily *Caphyrinae*, about a dozen species of the genus *Caphyra* have been described, mostly from the Red Sea and Indian Ocean. They are all small in size with the flagellum of the antenna excluded from the orbit, the antero-lateral border of the carapace toothed and the last pair of legs subdorsal in position, not much flattened and the dactylus hooklike as in the preceding walking legs.

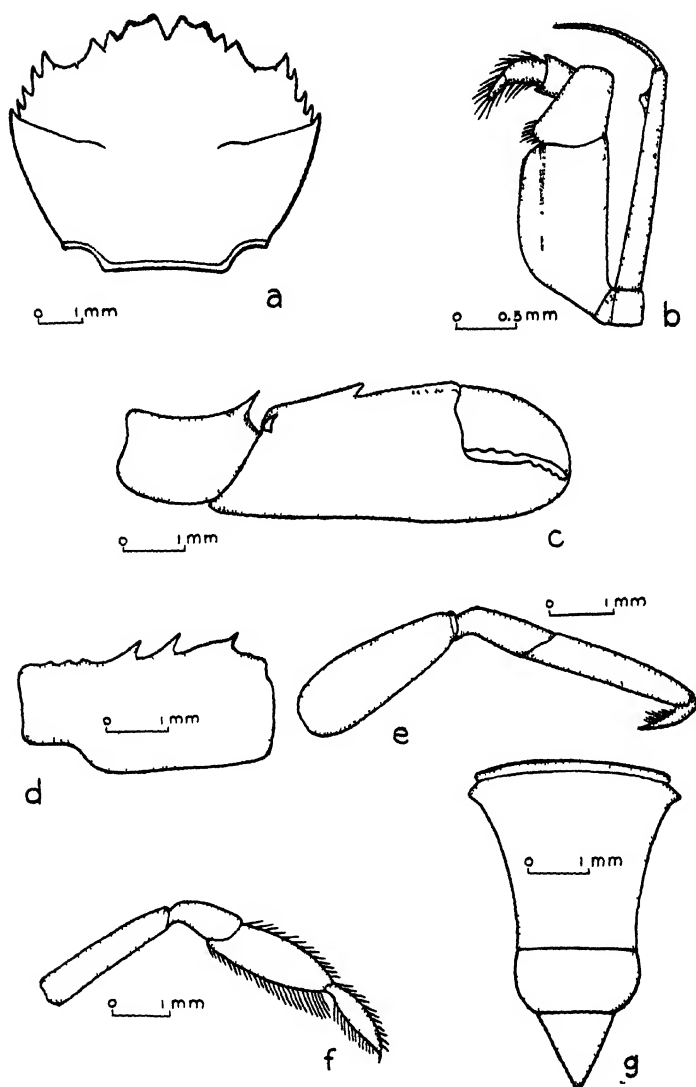


FIGURE 6.—*Caphyra suvaensis*, new species: a, outline of carapace; b, third maxilliped; c, carpus and hand of cheliped; d, merus of cheliped; e, first walking leg; f, last walking leg; g, telson of male.

***Caphyra suvaensis*, new species (fig. 6).**

Carapace broader than long, slightly convex, smooth and shining, marked only by a line beginning lateral to the gastric region extending outward and terminating on the last antero-lateral tooth. Front thin, advanced, deeply notched in the middle and cut into six teeth. Median tooth on each side more prominent than others, triangular, separated from the broader intermedial one by a shallow groove less than half the depth of the median notch. Lateral tooth of front narrower than either of the others, separated from the sharp supraorbital angle by a triangular notch. The line of the front curves backward on each side from the median pair of teeth to the supraorbital angles.

Supraorbital border with two faint notches; lower orbital border with a stout tooth at the inner angle visible from above. Antero-lateral border of carapace shorter than postero-lateral, bearing five sharp teeth, including the outer orbital angle, of which the fourth is the smallest. Outer maxillipeds with ischium longer than broad; merus as long as broad with median border diagonal.

Chelipeds long, stout and smooth, the right slightly larger than the left. Merus abruptly narrowed proximally, three teeth on the inner border, outer border smooth. Carpus with stout, sharp tooth at the inner distal angle. Manus compressed, increasing in height distally; upper border of palm crested bearing a sharp tooth about the middle and a short tooth on the outer border at the articulation with the carpus. Fingers compressed, slightly curved inward, crossed at tips when closed. Basal half of movable finger with low teeth on the cutting edge, immovable finger with similar teeth on the distal half of the cutting edge.

Walking legs long, slender, smooth, segments nearly cylindrical; dactylus hooklike fringed with hairs on lower border. Last leg subdorsal in position, propodus and dactylus somewhat flattened, both segments fringed with hairs. Abdomen of male with segments from two to five, inclusive, fused and lateral borders concave; sixth segment with lateral borders convex, seventh segment a narrow triangle.

Type specimen a male, breadth of carapace 8 mm, length 6 mm. Type locality, Fiji, on outer reef off Suva, in a dead coral head. Bishop Museum collections no. 3920.

Other known members of the genus apparently differ from this species either in the character of the front, the antero-lateral teeth, the chelipeds, or the abdomen. It seems to be near *Caphyra laevis* A. Milne Edwards (10), described from New Caledonia, but in that species the line of the front is straighter and there are but two teeth on the anterior border of the arm. In the specimen from Fiji the dactylus of the last leg is slightly broader than the corresponding segment in other species.

Genus PORTUNUS

It is of some interest to ~~discover~~ in the shoal waters of Oahu a small swimming crab apparently representing a species hitherto considered to be confined to the Atlantic Ocean. The type locality

is the Cape Verde Islands and, in addition, the previously known range included the West Indies and Ascension Island

Portunus (Portunus) vocans (A Milne Edwards) ? (fig. 7)

Neptunus vocans A Milne Edwards, Soc Philom Paris, Bull, (7) vol 2, p 225, 1878

Portunus (Portunus) vocans Rathbun, U S Mus, Bull 152, p 60, pl 25, text figs 8, 9, 1930

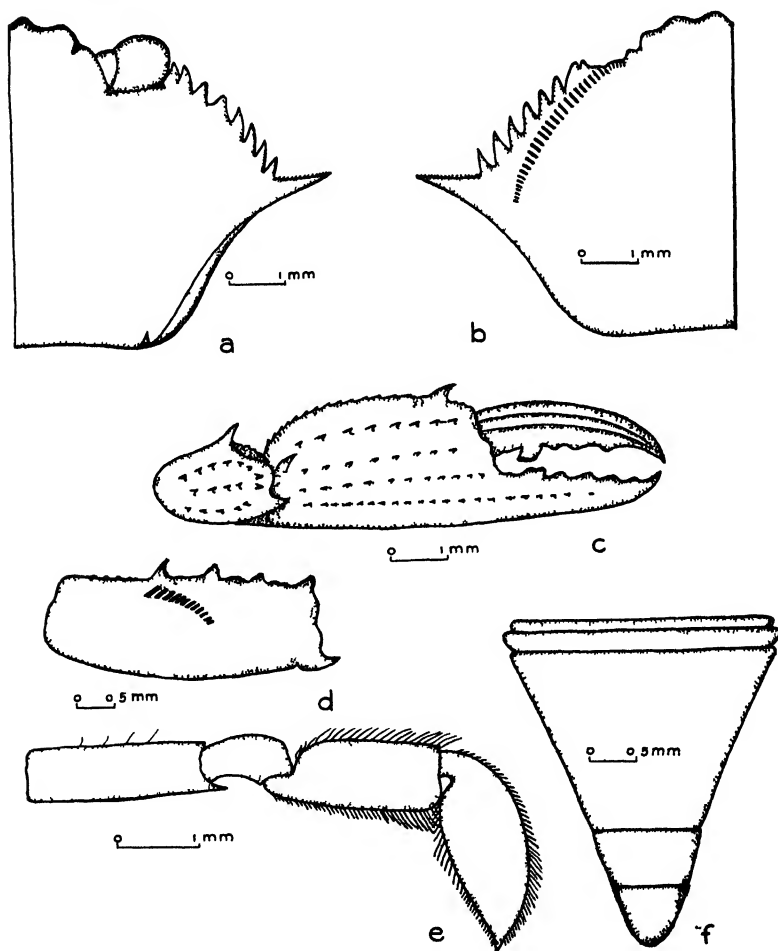


FIGURE 7—*Portunus (Portunus) vocans* (?) a, outline of right half of carapace, b, lower surface of carapace showing stridulating organ, c, outer surface of carpus and hand, d, upper surface of merus of cheliped with stridulating organ of this segment, e, swimming leg, f, telson of male

Characters of the Hawaiian specimen

Carapace broad, upper surface tuberculate; four tubercles in a curved transverse line across the gastric area, the concavity of the curve directed forward; behind these tubercles a granulated line extending transversely across the carapace curving backward to traverse the long lateral spine; an elevated ridge extending transversely across the cardiac region with a tubercle at either end. Front with 4 lobes, the median ones more tooth-like and more advanced than the lateral ones. A sharp tooth at the postero-lateral angle of the carapace is curved upward and forward. A stridulating organ consists of two portions, first, a row of short striae close to the lateral margin of the carapace on the under surface curving backward from the orbit, the striae becoming shorter as they recede from the margin, second a curved row of striae on the upper surface of the merus of the cheliped. Merus of cheliped with inner border serrated and spinous, a small sharp spine at the distal end of the outer border; carpus with a strong spine at the inner angle; outer and upper borders strongly serrated; palm with a tooth in front of the articulation with the carpus and one on the upper border near the distal end; upper border of palm serrated and four other longitudinal rows of serrations on the outer surface; fingers nearly as long as palm. Walking legs long, slender; merus of last leg with a tooth at the lower distal end. Telson of male triangular, segments 3 to 5 fused.

The presence of a stridulating organ distinguishes this species from others of the genus. For the most part the Hawaiian form, which is probably a young specimen, agrees with the typical species. In outline of the carapace, the distribution of the tubercles, in arrangement of the stridulating apparatus and in the general form of the appendages and telson the specimen from Oahu closely corresponds with previous descriptions of the species. The narrower median lobes of the front are, in the Hawaiian specimen, on a little lower level than the broader lateral ones, and the anterior border of the merus of the cheliped bears 4 spines instead of 2 and a tubercle as in the typical species.

When alive the Hawaiian form is conspicuous by color bands of red which encircle the chelipeds and walking legs. Except in the last leg the dactylus and carpus are each encircled by one red band and the propodus and merus by two such bands. The merus of the last leg has but one color band.

Size of the type specimen is recorded as 22 mm long and 43 mm broad. The length of the carapace of the Hawaiian specimen is 6 mm and the breadth 11 mm. Collected at Maile Point, Oahu. Bishop Museum collections no. 3772. *12345*

Should this small specimen prove to be identical with *Portunus vocans* it would not represent the first appearance in Hawaiian

waters of marine forms typical of the Atlantic Ocean. In Pearl Harbor, Oahu, the barnacle, *Balanus eburneus* Gould, has become definitely established. This species is typical of the Atlantic seaboard, in harbors and migrating up the rivers for some distance. A hydroid, apparently identical with *Pennaria tiarella* McCrady of the Atlantic Coast, flourishes in Kaneohe Bay, Oahu. The introduction of these and other invertebrates into the Central Pacific area may have been accomplished by way of the hulls of ships or, in case of the barnacle, by shells of transplanted oysters. It is quite probable that swimming crabs also may be carried long distances among sponges or ascidians which frequently accumulate on the bottoms of ships.

Portunus sp. (fig. 8).

A small specimen of the genus *Portunus*, subgenus *Achelous*, having a narrow carapace with an advanced front, was collected on the shallow reef at Black Point, Oahu. The small size, width of carapace 6 mm, length 4.5 mm, would support the view that it represents an immature form but the characteristics presented do not seem to correspond to those of any previously described species.

Following Rathbun's monograph the specimen seems to be near *Portunus floridanus* Rathbun (22, p. 82, pl. 40) and *Portunus depressifrons* (Stimpson) (22, p. 84, pl. 41) but differs from each of those species in the character of the front, the chelipeds and the abdomen of the male. Following the older key of A. Milne Edwards the specimen is near *Portunus ordwayi* (Stimpson) (22, p. 71, pl. 33), (*Neptunus cruentatus* A. Milne Edwards), but differs in the front, chelipeds and merus of the swimming legs. In general contour and convexity of the carapace this small specimen bears some resemblance to *Portunus pubescens* (Dana), a species common in Hawaii, but differs from it in the form of the front and in the absence of spines on the posterior border of the merus of the cheliped.

Without designating a specific name for this minute specimen a brief description follows.

Carapace slightly broader than long, upper surface convex, smooth, marked by a faint line extending transversely across the gastric region and behind this another more conspicuous one which continues laterally curving backward and traversing the posterior tooth of the lateral margin. Front advanced, consisting of four rounded lobes, the median pair more toothlike and more prominent than the lateral ones from which they are separated by a shallow groove; lateral lobes separated from the rounded, salient supraorbital border by a

shallow depression. Posterolateral corners of the carapace smooth and rounded. Supraorbital border with two faint notches, the outer angle being a stout tooth. Anterolateral border of carapace bearing 9 teeth (including outer angle of orbit) of which the last is somewhat larger than the others.

Outer maxilliped with ischium slightly longer than broad; merus about as long as broad; exopodite and flagellum stout. Left cheliped only developed, right one in process of regeneration; merus stout, thicker in the middle, inner margin serrated and bearing three spines which increase in size distally; pos-

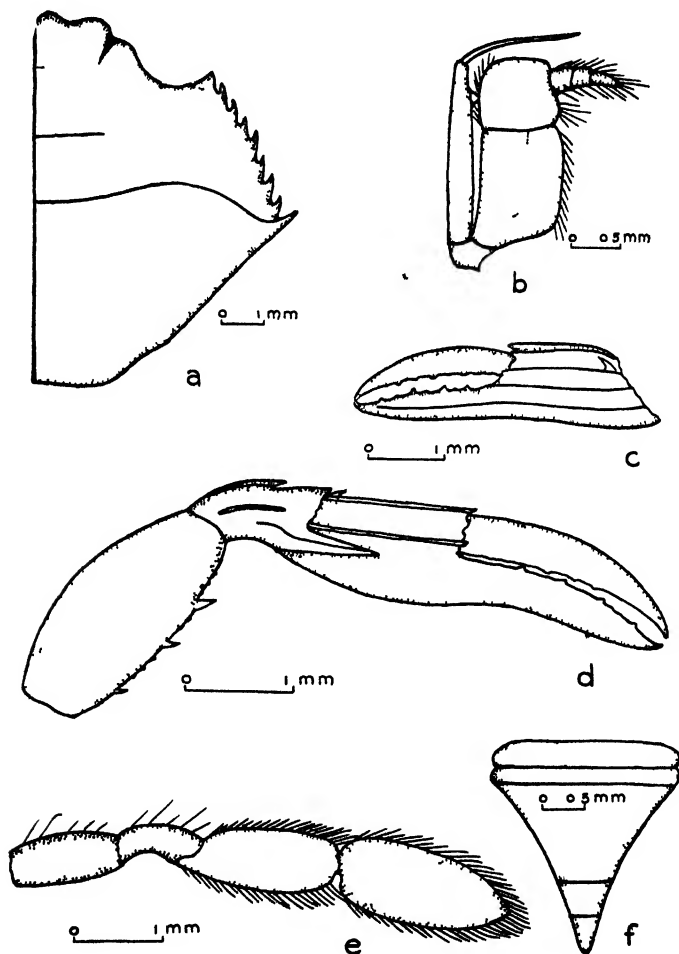


FIGURE 8.—*Portunus* sp.: a, outline of right half of carapace; b, third maxilliped; c, hand of left cheliped; d, medial view of left cheliped; e, swimming leg; f, telson of male.

terior border unarmed. Inner angle of carpus bearing a stout tooth about one-half as long as the palm of the hand, outer and upper surface with low carinae, the outer one terminating in a sharp spine. Manus of hand with five carinae on upper and outer borders, the two upper ones terminating distally in sharp points; a sharp spine on outer border on front of articulation with carpus; inner border of manus smooth, lower border rounded and smooth. Fingers longer than upper border of palm, slender, the cutting edges with a few low teeth.

Fifth leg unarmed, propodus and dactylus with margins densely haired. Abdomen of male with lateral borders of segments 3 to 5 concave; seventh segment a narrow triangle. Bishop Museum collections no. 3855.

FAMILY XANTHIDAE

Genus ACTAEA

Actaea dentata, new species (pl. 1, B; fig. 9).

A species of the *Banareia* type with fingers of the chelipeds thin and sharp and the surface of the carapace and legs almost completely concealed by tufts of hairs some of which are longer than others giving especially the front, lateral borders, and legs a shaggy appearance.

Carapace three-fourths as long as broad; upper surface when denuded presenting a smooth appearance, flattened transversely, anterior half convex longitudinally. Areas of surface separated by smooth shallow grooves, the deepest furrow being at the posterolateral border of the cardiac region.

Surface of carapace bearing sparsely scattered tubercles which near the antero-lateral borders are combined into raised groups of from three to five of unequal size; on the posterior half of the carapace the tubercles become smaller and more numerous. The tubercles are surrounded by areas of shallow pits which bear tufts of hairs of two lengths; some tubercles are pitted and bear hairs. Many slightly elevated areas also bear hairs but are without tubercles.

Front deeply notched in the middle with two broadly rounded medial lobes more prominent than the toothlike lateral ones which are separated from the inner supraorbital angles by slight depressions. Median lobes edged by a few granules and densely haired on the margin. Upper orbital border with two broad notches and bearing small tubercles and a thick coat of hair. Close behind the frontal margin and parallel with it is a shallow furrow, smooth and free from hairs but concealed until the surface is denuded. A similar but narrower furrow parallels the posterior border of the carapace. Lower orbital border granular and haired with a deep notch at the lateral and a broad tooth at the medial extremity.

Antero-lateral border of the carapace with four stout teeth, the first at the outer orbital angle; the three following are conical, tipped with pearly tubercles and directed forward and upward. Each bears tubercles on the upper and posterior border and is covered with long hairs concealing the margin of the carapace. The first and second teeth are separated by a wide space. Of the four teeth the second is the smallest.

Third maxilliped with ischium slightly longer than broad; merus broader than long with a medially directed lobe; exopodite and flagellum stout.

Chelipeds stout, in type specimen the right slightly larger than the left; arm shorter than wrist, surface smooth except for a few tubercles on upper and lower borders near the distal end; a short tooth behind a deep notch near the distal extremity of the upper border. Carpus with a stout tooth at inner angle, outer surface bearing tubercles arranged in groups, a furrow near the anterior border and parallel with it. Larger hand two-thirds as high as long, palm with a few groups of tubercles on upper border; outer border, for the most part, covered with tubercles, those toward the upper border arranged in groups; antero-ventral border including the immovable finger and the medial surface of the palm smooth. Dactylus with tubercles on upper and lateral borders of basal half; fingers laterally compressed, slightly curved inward and bearing low teeth on the cutting edges. Hand of larger cheliped densely clothed with long hairs except the antero-ventral and inner borders and the distal half of the dactylus. Outer face of palm of smaller hand granulated and haired throughout.

Merus of walking legs smooth except for a few tubercles on upper and lower borders, a shallow notch near the distal end of the upper margin; carpus and propodus bearing tubercles on upper and outer borders, carpus longitudinally grooved near the upper margin, dactylus long and slender. Legs clothed with long hairs except dactylus. Abdomen of male elongate, triangular with all segments distinct, first segment long, third one the broadest.

Type locality specimen a male, width of carapace 24 mm, length 18 mm. Type locality Tongatabu, in shallow water. Bishop Museum collections no. 3847. Other specimens in the Bishop Museum are from the shoal waters of Vitilevu and Oahu besides cotypes from Tongatabu.

Several previously described species bear some resemblance to the one here recorded but each seems to differ from it in certain specific characteristics. In *Actaea kraussi* Heller (14), of which Odhner considers *Banareia inconspicua* Miers from north Australia a synonym, the carapace is marked by raised lobules covered with granules, the front consisting of four equal lobes and the antero-lateral borders are cut into blunt granulated lobes. In *Actaea armata* (A. Milne Edwards) (10) the carapace which is closely covered with pearly granules has the median lobes of the front feebly developed and the antero-lateral border bears four granulated lobes. The species *Actaea villosa* (Rathbun) (20, p. 854, pl. 9, fig. 15), dredged by the Albatross near Laysan Island, has the carapace covered with granules of irregular size and bears about 13 large red granules scattered regularly over the surface. The front is deeply four lobed and the antero-lateral border consists of 4 thick, narrow

granulated lobes the last interspace being the greatest. In character of the front and surface of the carapace *Actaea banarceias* Rathbun (24) seems near to the species here described but has irregular granulated lobes on the antero-lateral border instead of distinctly conical teeth.

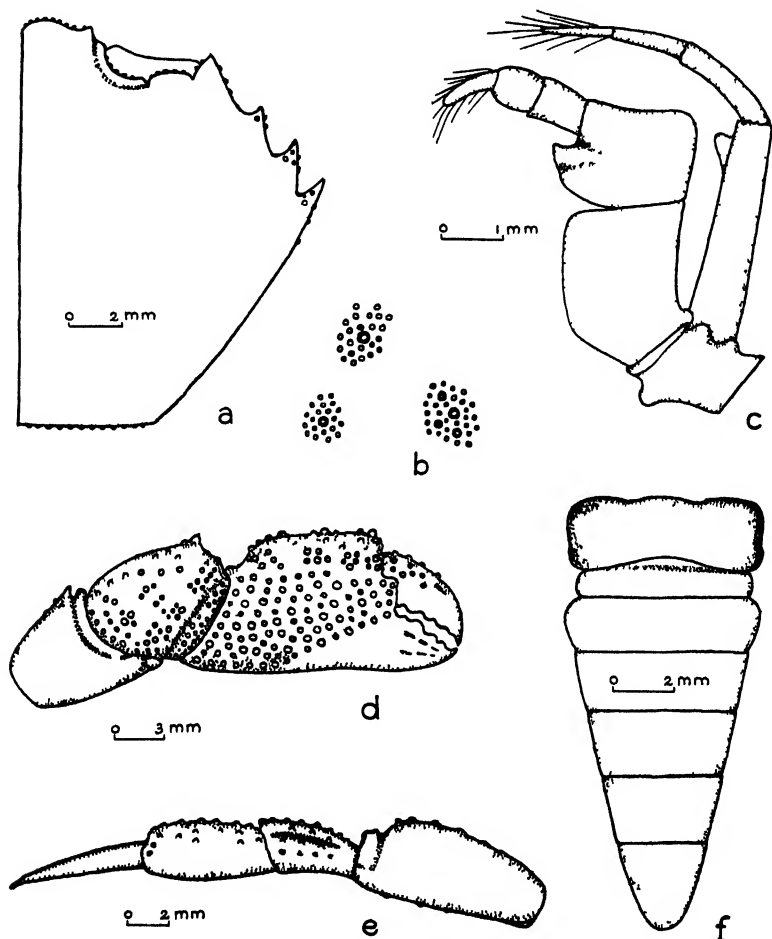


FIGURE 9.—*Actaea dentata*, new species: a, outline of right half of carapace; b, groups of tubercles near lateral border of carapace (enlarged); c, third maxilliped; d, right cheliped; e, first walking leg; f, telson of male.

Genus NULLICRINIS, new genus

Carapace broader than long; front strongly curved down; frontal margin concave; orbits large, border entire, situated far apart and remote from the epistomal region. Basal antennal joint fused with subfrontal area, flagellum wanting. Carapace and chelipeds ornamented by tubercles and covered with a short pile.

Nullicrinis amplifrons, new species (pl. 2, *A*; fig. 10, *a-e*).

Carapace broader than long, strongly convex longitudinally, and the front curved down in front of the eyes; true frontal margin concave, granulated. Areas faintly outlined; surface covered with smooth round tubercles and a dense yellow pile which does not completely conceal the tubercles. Antero-lateral border rounded, bearing four slightly differentiated lobes from the last of which a row of large granules extends obliquely inward. Carapace rapidly converging behind the fourth antero-lateral lobe to a narrow posterior border. Portion of carapace curved down in front of the eyes, including epistomal area, expansive; antennules folded transversely; basal antennal segment fused with subfrontal area and flagellum wanting. Third maxilliped with ischium a little longer than broad; merus broader than long; exopodite stout. Orbits large, oval, directed upward, situated far apart and remotely separated from the angle of the epistome; orbital border but slightly elevated, entire.

Chelipeds similar except right one, in type specimen, is slightly larger than left; arm short, thick, triangular in cross section, outer surface granular; wrist larger and stouter than arm, outer convex surface granular and tubercular, inner distal angle blunt, bearing a few short spines. Hand short and thick, height of palm equal to its length, upper border and outer surface granular and tubercular, the tubercles round and smooth as those of the carapace and scattered over the entire surface including base of the fingers. Upper margin of palm sharp, lower border broad and rounded; inner face inflated, upper half roughened by tubercles; fingers short, stout, strongly toothed and somewhat hollowed out at the tips. Cheliped covered with short pile like the carapace.

Walking legs compressed, upper and lower borders bearing granules, some of which are sharp; dactylus large, stout, slightly shorter than propodus; segments of legs with a few yellow bristles.

Color of preserved specimen yellowish-white; pigment of eyes and base of fingers of chelipeds black; tips of the latter pale brown. In a smaller cotype specimen the fingers are white.

Type specimen an ovigerous female, width of carapace 6.5 mm, length 5 mm. Type locality, Christmas Island, North Pacific Ocean. Bishop Museum collections no. 3922.

This small Xanthid is obviously near *Euriphides* Rathbun (22), having a very wide fronto-orbital border and the antenna excluded from the orbit. It differs, however, from that genus in the frontal margin, in the complete fusion of the basal segment of the antenna and the absence of its flagellum.

Genus LIOXANTHODES

Lioxanthodes pacificus, new species (pl 2, B, fig 10, f-i).

Carapace broader than long, anterior half strongly convex longitudinally, surface smooth with little demarcation of areas, from the greatest width a short distance behind the eyes the carapace rapidly converges to a narrow pos-

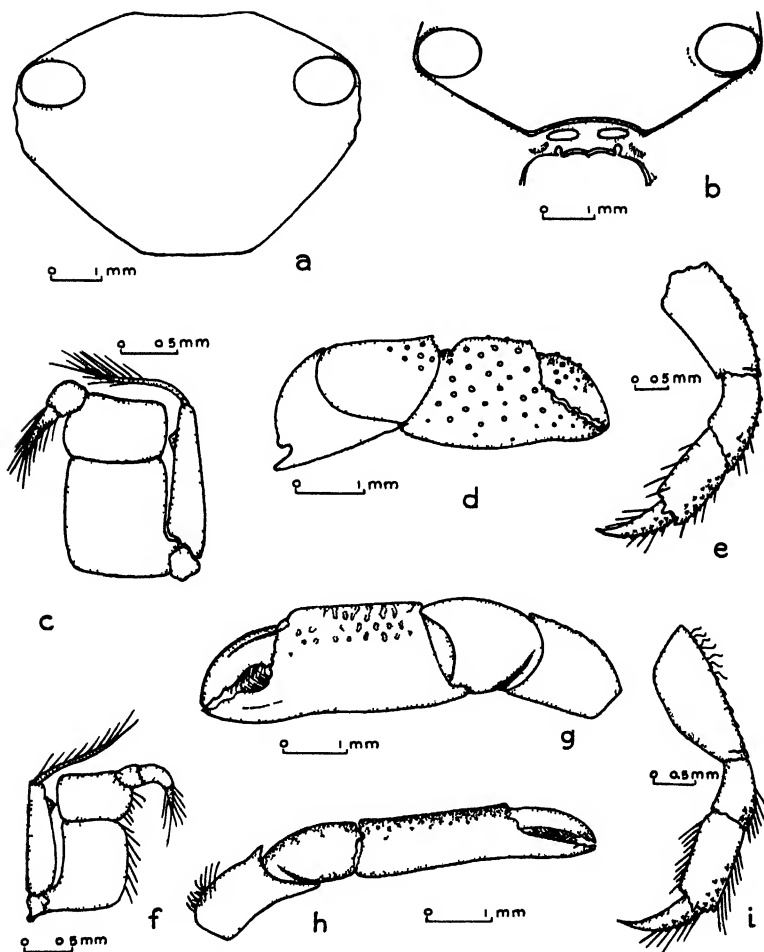


FIGURE 10—*Nullicrnis amplifrons*, new species a, outline of dorsal surface of carapace, b, front view of carapace, c, third maxilliped, d, right cheliped, lateral surface, e, walking leg

Lioxanthodes pacificus, new species f, third maxilliped, g, left cheliped, h, right cheliped, i, first walking leg

terior border. Front greatly deflexed, its margin with a shallow depression in the middle, the lateral lobes merging with the inner orbital angles. From the frontal depression a shallow groove extends backward to the gastric region; another shallow groove parallels the inner half of the supraorbital border then curves medially toward the gastric area.

Antero-lateral borders thick and rounded with traces of three lobes. Orbits large, the transverse diameter the greater; border entire except for a medial hiatus in which the flagellum of the antenna rests. Eye-stalks thick, filling the orbit when contracted. Basal antennal segment short and stout, meeting the inner suborbital angle and the front with the flagellum which is a little longer than the greatest diameter of the orbit resting in the hiatus.

Outer maxilliped with ischium little longer than broad, merus broader than long with medial border entire; in width the exopodite more than one-third that of the ischium.

Chelipeds long and stout, unequal in size; the larger one, the left in the type specimen, with a short thick merus, the surfaces of which are smooth, upper sharp border serrate, terminating in a blunt point. Height of carpus subequal with its length, thick, smooth, but having a minutely pitted appearance under high magnification; inner surface drawn into an obtuse point about the middle.

Palm of hand thick, longer than high, upper and lower borders rounded; upper border and upper outer surface marked by transverse folds and wrinkles; lower down and on outer face are numerous low, smooth tubercles irregularly distributed; lower outer surface under lens has appearance of being irregularly pitted; inner surface of palm slightly swollen and smooth. Fingers stout, grooved and toothed, sharp pointed, with a mass of hair at the base.

Small cheliped as long as the larger one but less than one-half its volume, surface smooth; hand long and slender, having a minutely pitted appearance under a lens. Fingers grooved, toothed and hollowed out at the tip; hair fills the space at the base.

Walking legs slightly compressed, the upper border with sharp granules and hairs, both of which are more numerous on propodus and dactylus. Color of preserved specimens pale brown.

Type specimen a female, breadth of carapace 5 mm, length 3 mm. Type locality Washington Island. Bishop Museum collections no. 3919.

This minute crab, collected by the Whippoorwill Expedition in 1924 at Washington Island (type locality) and Howland Island, is close structurally to *Lioxanthodes alcocki* Calman (7), collected by Andrews at Christmas Island (Indian Ocean). The Indian Ocean species was the type of the genus and apparently the only species recorded up to the present time. From it the species here recorded seems to differ chiefly in the sculpture of the chelipeds. In *L. alcocki* the merus of each cheliped has smooth borders and the external surface of the palm of the larger hand is marked by longitudinal rows of low smooth tubercles. The fingers of both hands are sharp pointed. Also the medial border of the merus of the external maxilliped in

L. alcocki presents a notch in addition to the depression in which the palp rests, while in the species from the Pacific Ocean the medial border of this segment is entire.

The two specimens collected by Andrews at Christmas Island were ovigerous females. Seven specimens in the Bishop Museum from Washington and Howland islands are all females.

Genus ETISODES

Etisodes bifrontalis, new species (pl. 2, C; fig. 11).

Carapace twice as broad as long, anterior two-thirds of upper surface well areolated, convex in both directions, posterior third flattened and but slightly grooved. Front prominent, separated in the middle by a deep notch; median lobes with distinct dorsal and ventral margins, granulated, sloping obliquely from the middle notch to the knoblike lateral lobes which are separated by a deep wide notch from the prominent inner orbital angles.

Lobules of carapace closely covered by microscopic granules, tending to become scabrous on post-frontal and branchial areas, some of the lobules being bordered anteriorly by large granules. Superior orbital border tumid, granular, with two distinct notches; inferior border visible from above, a blunt lobe at both outer and inner extremities, the median one the larger, intervening border bearing large granules. Outer orbital angle a blunt tooth followed by four granulated antero-lateral teeth all directed forward, the first and second blunt lobes, the third and fourth narrower and more pointed, the last being sharp. There is an additional blunt tooth between the outer orbital angle and the first antero-lateral tooth, but at a lower level. Margin between base of last three teeth bearing strong conical granules. A narrow transverse groove just in front of the posterior border of the carapace, its posterior margin finely granulated. Postero-lateral margin and lower side walls of carapace covered with long hairs.

Merus of third maxilliped quadrangular, anterior border nearly straight, a deep notch on median border and a smaller one at antero-medial angle.

Chelipeds stout, unequal in type specimen, left one the larger; merus with anterior margin armed with strong granules which become stout conical teeth proximally; posterior margin granular. Wrist with a blunt tooth at inner angle, outer surface finely rugose above, a prominent rounded eminence near articulation with hand. Tufts of long hair are borne on the anterior and posterior borders of the merus and the inner surface of the carpus. Palm of large hand increasing in height distally, upper margin bearing a large tubercle near proximal end and a slight swelling near the middle. A broad, shallow furrow extends longitudinally on the outer face near the upper margin; upper three-fourths of outer surface of palm faintly rugose by irregular transverse lines of granules; lower portion and broadly rounded ventral border smooth.

Palm of smaller hand with an elongated eminence at the proximal end of the upper border and lateral to this four less prominent elevations in a longitudinal row. A longitudinal depression similar to that of the larger hand on the upper outer face of the palm and similar rugosities which, however, are more pronounced and extend lower down.

Fingers of both hands, in type specimen, smooth and rounded, in contact only at the broadly hollowed out tips; dactyli with three slightly elevated lobes on the dorsal border close to the articulation with depressions between; dactylus of larger hand with three teeth on cutting edge, the largest one distal of the middle; immovable finger with three small teeth, the largest one more distal in position; dactylus of smaller hand with three small teeth on the cutting border, the immovable finger with two. Tufts of bristles occupy the hollowed tips of the fingers.

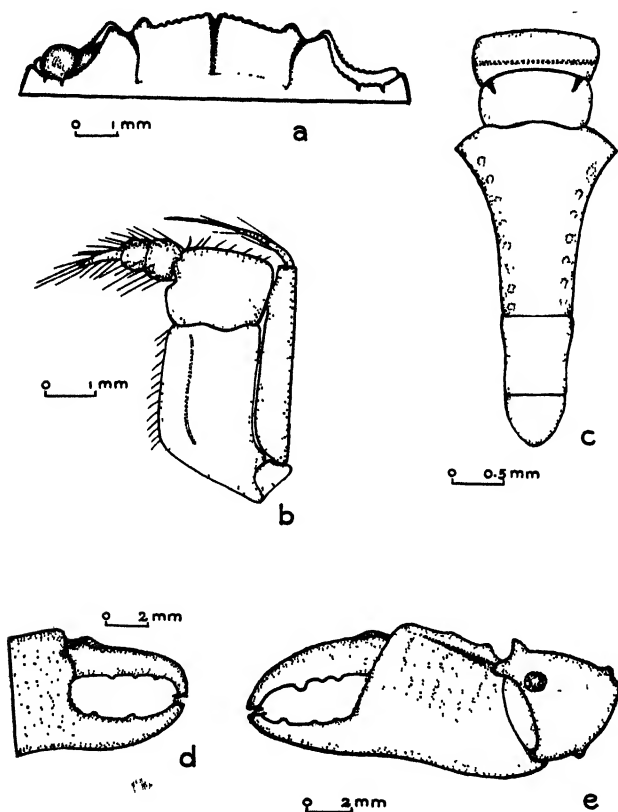


FIGURE 11.—*Etisodes bifrontalis*, new species: *a*, dorsal view of anterior region of carapace including orbits; *b*, third maxilliped; *c*, telson of male; *d*, distal extremity of manus of smaller cheliped; *e*, carpus and manus of larger cheliped.

Carpus and carpus of walking legs smooth on anterior and posterior surfaces, with a row of short sharp granules on dorsal border; propodus with two rows of spines above; dactylus slightly longer than propodus and longitudinally grooved, armed with rows of strong spines. All segments bear long hairs.

Abdomen of type specimen (male) with first and second segments much narrower than the third, a transverse furrow traversing the first near its distal border; third, fourth and fifth segments united, a row of slight depressions near each lateral margin; sixth segment longer than broad; seventh shorter than breadth of base.

Type specimen a male, breadth of carapace 22 mm, length 11 mm. Type locality Pearl and Hermes Reef. Bishop Museum collections no. 3921.

This species which is very near *Etisodes frontalis* as described by de Man (17) apparently differs from that species in the following features: The carapace is not so broad in proportion to its length and the surface is not so completely or so deeply furrowed. The inner frontal lobes are more oblique than in *E. frontalis* and the lateral frontal lobes are more prominent. There is no transverse groove separating the cardiac from the intestinal region. The inner angle of the wrist bears a single blunt tooth instead of two and there is no tooth at the base of the cutting edge of the dactylus of the larger hand. The smoothness of the dactyli seems to be an age characteristic, as in younger specimens these segments are longitudinally grooved.

The present known range of this form is from Palmyra Island through the Hawaiian Archipelago as far as Pearl and Hermes Reef.

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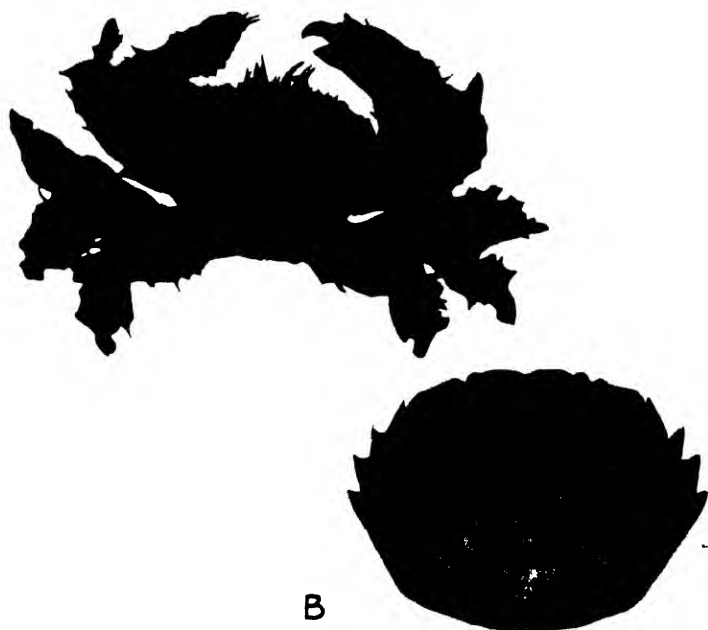
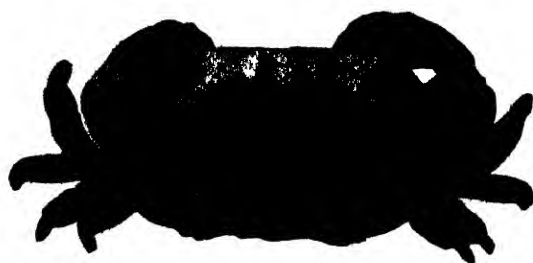
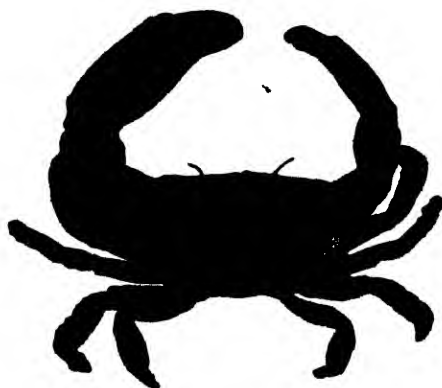


PLATE 1.—*A*, *Actaeomorpha punctata*, new species, dorsal and ventral view, $\times 4$; *B*, *Actaca dentata*, new species, dorsal surface and dorsal surface of denuded carapace, $\times 2$.



A



B



C

PIATE 2—A, *Nullocrinus amplifrons*, new species $\times 6$; B, *Luoxanthodes pacificus*, new species, $\times 6$; C, *Etsodes bifrontalis*, $\times 15$.

New Delhi

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